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ENVIRONMENTAL RESEARCH

TECHNOLOGY TRANSFER CONFERENCE • 1988

Environment Ontario

Jim Bradley, Minister

ABSTRACTS

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ABSTRACTS

TECHNOLOGY TRANSFER CONFERENCE

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Introduction

Environment Ontario holds its annual Technology Transfer Conference to report and publicize the progress made on Ministry funded environmental and health related research projects. These studies are carried out in Ontario universities and private research organizations.

This book presents the abstracts of the papers presented at the Technology Transfer Conference 1988, to be held on November 28 and 29 at the Royal York Hotel.

Abstract Book Instructions

The abstracts are divided into five research sections, corresponding to the conference sessions as follows:

Air Quality	- Session A
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The abstracts run from Session A to Session E, in numerical order within each research section.

Examples of the abstract numbers are:

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Air Quality poster presentation = AP1, AP2....

For further information on any of the projects, please refer to the Conference Proceedings or to the principal investigators. The Conference Proceedings will be available on-site at the conference.

Disclaimer

The views and ideas expressed in these papers are those of the authors and do not necessarily reflect the views and policies of Environment Ontario, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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DERIVING BENEFITS FROM ENVIRONMENTAL RESEARCH;
S. Smith, Rockcliffe Research and Technology Inc.,
Ottawa, Ontario.

SEE AIR QUALITY RESEARCH SESSION A PROCEEDINGS
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SESSION A

AIR QUALITY RESEARCH

Oral Presentations

AIR QUALITY RESEARCH

Walter Chan
Air Resources Branch
Environment Ontario

The Air Quality Research Needs Document reflects the Ministry's mandate to protect the environment and human health, specifically as it is related to air pollution. The current research requirements are grouped under six categories, thirteen issues, and fifty-three needs. As one might reasonably expect, many of these entries are inter-related.

The six categories fall into two groups: primary and ancillary. The former includes the three basic components in the understanding of air pollution, namely, the environmental impacts/receptor (contaminant effects/toxicology/fates), the source (sources/inventories), and the intermediate processes (atmospheric processes) between the source and receptor. The latter includes regulation (risk management and criteria development), abatement (control and remedial technology) at the source and receptor, and sampling (instrument development and application), which is necessary for source, receptor and process studies.

Each category is broken down into issues which define the area of research more concretely, e.g. contaminant effects into human, ecosystem, and phytotoxicology; and sources into industrial/commercial, stationary/domestic, and mobile sources.

Under each issue, particular research needs are listed. These needs are meant to provide general rather than specific guidance to prospective applicants. Because of the nature of the categories and issues, many of the research needs can be linked to issues other than the one under which they are grouped. Also, atmospheric research is not independent of other environmental disciplines, readers are therefore encouraged to look at other research areas cross-referenced at the bottom of each issue page.

A1

SCIENCE AND POLICY: PHOTOCHEMICAL OXIDANTS AND ACID BEARING SPECIES; K.L. Demerjian, Atmospheric Science Research Centre, State University of New York, Albany, New York, U.S.A.

SEE AIR QUALITY RESEARCH SESSION A PROCEEDINGS BOOK FOR THE EXTENDED ABSTRACT.

A2

RELATIONSHIP BETWEEN FOREST DECLINE AND ROOT HEALTH IN ONTARIO SUGAR MAPLE STANDS. Cindy Adams*, Marika Egyed and Tom Hutchinson, Institute for Environmental Studies, University of Toronto, Toronto Ontario M5S 1A1.

We have initiated a study to examine fine root systems of sugar maple trees in Ontario in an attempt to determine whether fine root damage is a factor in their present decline. Roots of healthy and declining sugar maple are being compared for their health, biomass, mycorrhizal infection, branching patterns and chemical composition. Results from several greenhouse bioassays and also from a field experiment have shown a substantial reduction in root growth into soil collected from declining trees. In the greenhouse experiments we compared the growth of seedlings in either healthy or declining tree soils from several Ontario and Quebec sites, while in the field experiment we used mesh bags (ingrowth cores) filled with these same soils buried around healthy and declining trees after removal of soil cores to a depth of 10 cm. The observed reduction in root growth is consistent with lower concentrations of Ca,P,Mg and Mn and increased Al in, the soils from declining trees at several sites in the Huntsville - Parry Sound areas in Ontario. Roots grown in the declining tree soils had lower levels of Ca, Mg,and P and in some cases elevated Al. These results, together with the fairly low pH values in these forest soils (3.5 - 4.5), suggest a possible alteration in the mycorrhizal status of sugar maple in relation to decline. We are presently investigating this aspect.

These studies are funded by the Natural Science and Engineering Research Council and The Ontario Ministry of the Environment.

A3

A NUMERICAL DECLINE INDEX RATING SYSTEM TO MONITOR CHANGES IN TREE CONDITION OF HARDWOOD FOREST SPECIES. D.L. McLaughlin*, W.D. McIlveen, W.I. Gizyn, D.E. Corrigan, R.G. Pearson and R. Arnup, Ontario Ministry of the Environment, Air Resources Branch, Phytotoxicology Section, 880 Bay Street, Third Floor, Toronto, Ontario, M5S 1Z8

A numerical rating system was developed to assess the condition of individual hardwood trees in Ontario. The rating formula combines a series of subjective assessments of crown branch and foliar attributes and weighs them proportional to the live crown resulting in a numerical value termed a Decline Index which ranges from 0 (healthy, no symptoms) to 100 (dead tree). Individual tree Decline Indices are meaned to express a Decline Index on a fixed plot basis. Re-evaluation of the same trees provides a temporal perspective of changing forest condition. Data from 11 test plots established in the hardwood forest region of Central Ontario in 1984 and evaluated annually with this system were examined statistically using Least Significant Difference analysis. The plots were ranked by their Decline Index value and changes recorded through the four year period 1984 to 1987. It was determined that hardwood tree condition at these sites has either stabilized (no significant change) or had improved. At no site was the average Decline Index significantly higher (tree conditions deteriorated) in 1987 relative to 1984. The Decline Index methodology was used in a province-wide hardwood decline survey initiated in 1986 and successfully identified regions of varying forest condition. Interest in the rating system by other Provinces and States has prompted stringent quality control testing planned for the 1988 field season.

A4

INVESTIGATION OF SHORT-TERM MUTAGENICITY AND CHEMICAL COMPOSITION OF ORGANIC SOLVENT EXTRACTABLE FRACTION OF COKE OVEN EMISSION. A.J. Horton*, N. Belson, K. Shaw and G.H. Thomas, Ontario Research Foundation, Sheridan Park Research Community, Mississauga, Ontario, CANADA L5K 1B3

This study represents part of a program the overall objective of which is to determine whether a practical ambient air standard for PAH based on their mutagenic activity is possible. In order to obtain large amounts of PAH for experimental work, sampling was conducted at coke oven sites. Hi-Vol filters plus backup polyurethane foam samples were collected directly from coke oven lids (LIDS) and top side (COTS) locations. Concurrently, Lo-Vol samples were collected in order to provide BSFTPM data for comparative purposes. The data generated includes total particulate matter (TPM), soluble organic fractions (SOF) and volatile organic fractions (VOF). Selected SOFs and VOFs were subjected to tiered biological testing (Ames & SCE-CHO) as well as qualitative and quantitative chemical analysis. Selected SOFs have been fractionated into carefully defined chemical fractions in order to better define the chemistry and better isolate the mutagenicity. The results will be discussed in the following terms: (1) Regression lines and correlation coefficients for Hi-Vol/Lo-Vol TPM and Hi-Vol/Lo-Vol SOFs, (2) Mutagen density (rev/m^3) versus Hi-Vol SOFs, (3) Possible relationships between mutagenicity and individual specific PAH compounds, (4) Mutagen density versus BSFTPM, (5) Coefficient of haze (COH) values and their correlation to SOF and mutagenic data.

A5

QUANTITATIVE MEASUREMENTS OF THE GENETIC EFFECTS OF INHALED CARCINOGENS IN PULMONARY FIBROBLASTS ARE NOW POSSIBLE.

John A. Heddle*, A. Bouch and John D. Gingerich, Department of Biology, York University, Toronto M3J 1P3

Methods for the routine measurement of chromosomal aberrations and gene mutations have been established for pulmonary fibroblasts after exposure to carcinogens in vivo. After exposure the fibroblasts are isolated by a procedure involving trypsin digestion, plated in vitro, and analysed. For mutations, the frequency of thioguanine-resistant cells is measured at 10 days, when they are most frequent. Plating efficiency is determined by seeding cells on a layer of lethally irradiated feeder cells. The potency of a carcinogen can be expressed as the frequency of mutant cells induced per unit dose applied in vivo.

For chromosome aberrations the frequency of micronuclei is determined after 3 or 4 days of in vitro culture, when they are most frequent, using an in situ assay. Currently experiments are underway to determine if the cytochalasin block method will make these measurements quicker or more sensitive. Again an in vivo mutagenic potency can be calculated.

Validation of these two measurements on carcinogens specific for the lung and for other sites is in progress and will be reported.

A6

SENSITIVITY OF ASTHMATIC CHILDREN TO AIR POLLUTION. L.D. Pengelly* and C.H. Goldsmith; Departments of Medicine, and Clinical Epidemiology and Biostatistics; McMaster University, 1200 Main St. West, Hamilton, ON, Canada, L8N 3Z5.

We are studying the respiratory health of school children in Hamilton, ON. Design, methods, and results have been previously reported to this meeting (OME Tech. Trans. Conf. 1981,3,4,6,7). Respiratory health of children 8-11 yr was assessed in 1980 by a questionnaire administered to the parent, and also by pulmonary function tests carried out in schools. The ambient (outdoor) environment was assessed by networks: Total Suspended Particulate (TSP); Fine Fraction (particles under 3.3 um: FF); and sulphur dioxide (SO_2). Spatial gradients in all three pollutants were found to exist over the city. One year mean exposures were calculated for each child according to the geographical location of their school. For each pollutant, children were divided into two groups: those with exposure above the median level and those below. Median levels were: TSP= 52ug/m^3; FF=46ug/m^3; SO_2=10.6 ppb. Each group was further divided into children with a physician diagnosis of asthma ("Asthmatic"; n=114), and those without ("Normal"; n=3057). Comparison of the value of the pulmonary function variable Mid-Expiratory Time (MET) was made between groups for each pollutant. No differences were found for either TSP or FF. In Normal children there was a statistically significant ($p<0.05$) but clinically unimportant lower value in MET (0.58s) observed for those above the median SO_2 exposure compared to those below (0.59s). In Asthmatic children there was a longer MET in both exposure groups, compared to Normal children, indicating an increase in airway obstruction expected in this syndrome. There was a statistically significant ($p< 0.02$) increase in obstruction in Asthmatic children above the median SO_2 level (0.83s) compared to those below (0.71s). Thus we observed that 1-year exposure to increased SO_2 in the 10-20 ppb interval is associated with an increase in airway obstruction in asthmatic children, not observed in normal children.

A7

HAZARDOUS CONTAMINANTS IN ONTARIO: ENVIRONMENTAL FATE AND HUMAN EXPOSURE

D. Mackay and S. Paterson, Institute for Environmental Studies, University of Toronto

During the last few years our group has been developing and testing various models which describe the environmental fate of hazardous chemicals in Southern Ontario. The current status of these models is reviewed. A capability now exists of estimating the prevailing concentrations of such chemicals in air, water, soil and sediments provided that physical chemical properties and emission rates are available. The models can vary in region of application, in complexity and can be steady and unsteady state in nature. In recent work, these models are being extended to assess the magnitude of exposure of a typical Ontario family by routes of air inhalation and water and food ingestion. The principal challenge in this work is quantifying the air-soil-vegetation-meat and dairy products route. The approaches being taken to develop reliable predictive procedures are discussed. Finally, progress is being made in developing pharmacokinetic models which enable these "external" exposures to be translated into concentrations or "internal" exposures in various human tissues. It is thus becoming possible to quantify the entire journey of a toxic chemical from emission source to human target organ and explore how these target concentrations will respond to various strategies of emission or loading reduction.

A8

VERIFICATION OF THE CLOUD AND WET DEPOSITION FIELDS OF A MESO-α SCALE MODEL OF LONG-RANGE TRANSPORT OF AIR POLLUTANTS.

Han-Ru Cho*, S.T. Soong and J.V. Iribarne, Department of Physics, University of Toronto, Toronto, Ontario, Canada M5S 1A7

The performance of the cloud and cloud chemistry fields of the long-range transport model of air pollutants developed at the University of Toronto is evaluated using observational data. The model was integrated for the 48-hour period beginning 00GMT, April 23, and ending 00GMT, April 25, 1981. The model-simulated cloud and precipitation fields are compared with observations using synoptic, surface, and satellite data. The simulated locations of cloud, cloud coverage, and cloud top heights and precipitation amounts compare favourably with observations. The model predicted wet deposition fields are compared with analyses obtained from OSCAR-4 data. The sensitivity of model results to the initial and boundary conditions used, and to the model physics and chemistry formulations is examined. The resolution of observational data required for model verification purposes will also be discussed.

A9

Eulerian Model Evaluation. M. Alvo, Department of Mathematics, University of Ottawa, Ottawa, Ontario K1N 6N5.

Sophisticated long range atmospheric transport models have recently been developed in order to study the relationships of source emission patterns and meteorological data to deposition in eastern North America for several species including sulphate. If accurate, comprehensive models can be used to formulate control strategies on the basis of source-receptor relationships. A rigorous evaluation of such models must take into account the accuracy of both the input data and the validation data; the subgrid scale of the validation data; and the space-time nature of the model.

A10

SCALE MODEL STUDIES AND DEVELOPMENT OF PREDICTION PROCEDURES FOR HEAVY GAS DISPERSION IN COMPLEX TERRAIN 1988. P.A. Irwin*, M.C. Murphy, and K.C. Heidorn, Rowan Williams Davies and Irwin Inc., Guelph, Ontario.

The overall objective is to develop a computer model which predicts the dispersion characteristics of a toxic heavier-than-air gas spill in an urban or complex terrain. Ultimately, the model will be used in the Emergency Response Program by the Ontario Ministry of the Environment. In the event of an actual spill, the Ministry will then have at its disposal an improved method of predicting cloud behaviour. To assist in developing the computer model, RWDI is performing scale model testing in a boundary layer wind tunnel to determine the effect of arrays of obstacles and non-uniform terrain on the path of a heavy gas cloud. The parameters of interest include: terrain roughness, cloud size versus obstacle size, flow path, arrival time, dilution rate, and concentration fluctuations. A modified box model approach is being developed to predict the cloud dispersion characteristics. Experimentally, cloud behaviour is being studied with flow visualization and measurements of gas concentration. In the simplest case, i.e. low wind over flat terrain, the wind tunnel data are compared with Thorney Island full scale releases. In complex terrain, flow visualization of simulated instantaneous releases of heavy gas is being used to supplement the findings from concentrations measured with a fast response Flame Ionization Detector. The paper presents results from the scale model tests of gas cloud releases in arrays of obstacles simulating buildings and describes current development of the computer model.

A11

AN INVESTIGATION OF WIND GENERATED PARTICLE TRANSPORT RATES WITHIN A TURBULENT BOUNDARY-LAYER.

A. D. Ciccone*, J. G. Kawall and J. F. Keffer, Department of Mechanical Engineering, University of Toronto, Toronto, Ontario, M5S 1A4.

Most research and experiments carried out on the movement of sand particles in air have been concerned with the total mass transport or flux of material from a surface. It has been established that the total rate of transport can be attributed to three modes of motion which are not mutually exclusive: saltation, surface creep and suspension. Here, saltation is the most important since it is a prerequisite for the other two. The empirically determined saltation rates for wind generated particle movement are, in many cases, not in accord. Investigators have either modified the constants in Bagnold's saltation formula or developed complicated empirical equations to determine the transport rates. These equations are not likely to give further insight into the physics involved in the transport mechanisms. An alternative procedure is to examine the various components of the transport rate and determine the parameters on which it depends. A novel flow-visualization/digital image analysis technique has been developed to determine individual particle trajectories, from which saltation rates can be computed. This technique involves recording individual particle motions, which have been illuminated with a strobed light source, on 35 mm high-speed film, digitizing the film and using a high-speed computer to track the particle trajectories. The transport rates are determined subsequently from the particle-trajectory data.

A12

INCINERATION OF WASTES; K. Davies, Environmental Protection Office, City of Toronto, Toronto, Ontario.

PAPER NOT AVAILABLE

A13

DETECTABILITY OF STEP TRENDS IN THE RATE OF ATMOSPHERIC SULPHATE DEPOSITION. Edward A. McBean*, Michel G. Kompter, and Grahame J. Farquhar, Department of Civil Engineering, University of Waterloo, Waterloo, Ontario, N2L 3G1

Step trend analyses are performed on acid deposition rates using a combination of monitored sulphate deposition data and a long-range transport of acid precipitation (LRTAP) model. The step trend analyses consider Sudbury's emissions and eastern North America's emissions to explore strategies for reducing sulphur dioxide emissions such that a decrease in sulphate deposition is detected in a specified time period. Results indicate Sudbury's emissions could be reduced with significant detectable reductions in sulphate deposition occurring at the Muskoka region. Significant detectable reductions do not occur elsewhere due to the variability of monitoring data "masking" the small change in sulphate depositions associated with abatement. Reductions in eastern North America's emissions would result in widespread evidence of significant detectable reductions.

A14

INCINERATOR AND STEEL PLANT CONTRIBUTIONS TO AIR PARTICULATES AS DETERMINED BY SIZE-SPECIFIC RECEPTOR MODELLING.

A.C. Chan*, Z-J Kang and R.E. Jervis, Dept. of Chemical Engineering and Institute of Environmental Studies.

The objectives of this study is to further develop and verify receptor modelling approaches capable of resolving mixed dominant emission sources in urban environments and achieving quantitative source apportionment through field sampling at selected control sites in Ontario. As an improvement over the previous research, an effort has been made to measure actual concentration 'profiles' for dominant sources rather than those derived indirectly, such as by sampling emission stacks. In order to apply factor analysis and chemical element balance to a data set of 20-25 filters, the concentrations of up to 35 elements in the airborne particulates were measured using both hi-vol samplers and cascade impactors at various control sites utilizing radioanalytical INAA and IPAA techniques. Size-sorting sampling was undertaken to facilitate the differentiation between emission sources possessing similar concentration patterns but different particle-size 'profiles'. Previous study at the E. Riverdale site(1) had proved that this approach was very effective. The Metro-Toronto sampling program involves air sampling at a site in Comissioners Street to investigate the impacts of waste incinerator and other mixed industries' emission in urban airsheds. Fly ash was obtained from the municipal incinerators and a hospital incinerator, and a discernible amount of Sb,As,Se,-Cd,Cl,Mn was observed. Varoius air samples collected in Sault-Ste Marie and Capreol were subjected to factor analysis to identify six and three prominent sources contributing to the receptor sites, respectively.

(1) "Receptor Modelling of Ambient Particulates at East Riverdale and at Toronto control Sites", R.E.Jervis, T.G.Pringle and A.C.Chan, Proceedings, Technology Transfer Conference Part 1 Air Quality Research (1987)

A15

A STUDY ON THE SOURCES OF ACID PRECIPITATION IN ONTARIO, CANADA. P.K. Hopke* and Y. Zeng, Inst. for Environmental Studies and Dept. of Civil Engineering, University of Illinois, 1005 W. Western Avenue, Urbana, IL 61801

Since 1980, the Acid Precipitation in Ontario Study (APIOS) Event Wet/Dry Deposition Network has collected a substantial precipitation chemical data base. Data from three stations in Dorset, Kingston and London were investigated. Factor analysis was applied to the chemical data sets. Three factors reproduce the observed concentrations. These factors represent the acid gas sources (SO_2 and NO_x emission sources), Ca and Mg sources (calcareous soil dust), and Na and Cl sources (marine aerosol). The acid gas sources are strongly related to the precipitation acidity. To locate the sources in terms of geographic region, air parcel back trajectories corresponding to the precipitation sampling periods are incorporated into factor analysis with the chemical data. This information is in the form of the geographic distribution of back trajectory endpoints. The region in which the trajectory endpoints fall is divided into subregions. New variables are defined as the number of the endpoints that fall in each subregion. The values reflect the residence time of an air parcel in the sub-regions. Factor analysis is applied to the combined chemical and endpoint variable data sets. The results show the relationship between the chemical nature of the sources and the geographic regions through which the air parcels passed. The potential source contribution function (PSCF) is another approach to locate the sources. PSCF is a conditional probability function calculated for each 1° longitude by 1° latitude cell by dividing the number of trajectory endpoints that correspond to samples with factor scores or pollutant concentrations greater than pre-specified values by the number of total endpoints in the cell. Source areas are indicated by high PSCF values. Both of the approaches suggest that the Ohio River Valley and some areas along east coast are major source areas for the observed precipitation acidity in Ontario.

A16

ADVANCED TECHNIQUES FOR MOBILE MONITORING OF TRACE ORGANICS IN AIR. G.B. De Brou*, E. Singer, M.A. Sage, R.W. Bell, R.E. Chapman, and D.J. Ogner, Air Resources Branch, Ontario Ministry of the Environment, Toronto, Ontario, M5S 1Z8.

The measurement of trace organic compounds in air poses several challenges to the analytical chemist. Often the compounds of interest are present at trace levels, for short, irregular time periods, in a complex chemical matrix. Since the early 1970's, the Air Resources Branch has recognized the need for state-of-the-art mobile laboratories to gather vital air quality data near the source in the affected community. The original mobile air monitoring units (MAMUs) were equipped to measure only a few classical pollutants, namely: sulfur dioxide, oxides of nitrogen, and carbon monoxide. Owing to the recent advances in analytical instrumentation and an enhanced awareness of volatile organic contaminants, the monitoring capabilities of the MAMUs have been vastly expanded. Today the Ministry operates four MAMUs which provide on-site measurements of a broad range of volatile organic and inorganic compounds. Our latest addition to the MAMU fleet is the mobile TAGA 6000E - a tandem mass spectrometer with real-time, direct air analyses. Supplementing the MAMUs are our lab-based instruments for verification of pollutant identities: an isolation matrix FTIR, triple capillary GC/MSD, and a dual oven GC. The MAMUs' unique capabilities have proven to be invaluable to the Ministry in a variety of monitoring applications: from tracking plumes of toxic gases in a small community to assisting the Ministry personnel in clean-up operations of chemical spills.

A17

ATMOSPHERIC TRACE GAS MEASUREMENTS USING A TUNABLE DIODE LASER ABSORPTION SPECTROMETER. D.R. Hastie and H.I. Schiff, Department of Chemistry and Centre for Atmospheric Chemistry, York University, North York, Ontario, M3J 1P3

Measurements of reactive trace gases in the atmosphere are important in improving our understanding of atmospheric chemistry. Measurements are necessary to determine what species are present and indicate those participating in chemistry. Accurate measurements of trace gas concentrations are required as boundary conditions to any model study. Finally, field measurements are the ultimate test of any model or hypothesis.

For a measurement to be useful it must be specific to the molecule being studied (specificity), have good signal to noise (sensitivity) and yet be on a time scale short compared to large scale atmospheric motions or solar irradiance variations. The tunable diode laser absorption spectrometer (TDLAS) is a highly specific, sensitive, fast response trace gas concentration measuring instrument, capable of measuring concentrations of two of a number of small molecules simultaneously.

In the summer of 1988 we used a TDLAS to obtain measurements of hydrogen peroxide (H_2O_2) and formaldehyde (CH_2O) at the Ministry's Dorset site, along with other techniques to obtain measurements of NO, NO_2, NO_x, NO_y, O_3 and CO. Other groups measured HNO_3, PAN, hydrocarbons, aldehydes, SO_2, CO particulates and precipitation. The result is a large dataset which will be used to test our knowledge of some areas of atmospheric chemistry and will be made available for testing of sophisticated atmospheric models.

A18

BIOMEDICAL WASTE INCINERATOR TESTING PROGRAM

V. Ozvacic, G. Wong, G. Marson, R. Clement, D. Rokosh, S. Suter, G. Horsnell, J. C. Hipfner, S. Burns, H. Corinthios; Ministry of the Environment

There are over 130 biomedical waste incinerators (BWIs) operated by Ontario hospitals. General hospital and pathological waste can be burned in these incinerators. The BWIs are small and either batch or semi-continuously fed. All contain afterburners or secondary stage burners complying with the Ministry's 1974 design criteria for the combustion gas residence time of 1/2 second at 1000°C but not with the 1986 criteria of 1 second at 1000°.

Presently, there are no measured air emission data for BWIs. Some preliminary measurements indicated that unburned organic matter may be emitted into the air from these incinerators. A testing program to measure these and other emissions - gaseous components, trace metals, microorganisms, toxic organics and radioactivity - at seven incinerators was initiated by the Ministry in 1987.

The purpose of the program is to develop data base required for the development of air emission standards and ash disposal guidelines; evaluation of incinerator design criteria; specification of abatement requirements; and for risk assessment.

Program description, objectives and preliminary results will be presented in this paper. The preliminary results indicate that toxic components were present in the air emissions from BWIs in quantities which may depend on incinerator type and the waste burned.

A19

A STUDY OF HIGH TEMPERATURE PHOTOCHEMICAL KINETICS OF SULPHUR DIOXIDE AND NITROGEN OXIDES FOR A FLUE GAS TREATMENT PROCESS.

J.E. Hunt*, P. Fellin, K.A. Brice, D.L. Ernst, D.R. Glendenning, R.B. Caton, C.S. Fung, K. Smith, Concord Scientific Corporation, Toronto, Ontario, M3H 2V2

A laboratory scale flow reactor was used to test a new photochemical based flue gas treatment process to remove SO_2 and NO_x from emissions from coal fired power generating stations. If cost effective, such a technology would have application in the reduction of acid rain. Tests were carried out under a variety of temperatures, gas concentrations, contact times, and light intensities. The removal of both SO_2 and NO_x were found to follow first order kinetics, with rate constants which decreased with increasing temperature for SO_2 but were variable for NO_x. Strong rate constant increases were observed for both SO_2 and NO_x with increasing light intensity.The quantum efficiencies were found to decrease with increases in temperature for both.Although independent of increasing concentrations of SO_2 and NO_x at room temperature, the rate constants were found to decrease at higher temperatures. The data support the hypothesis that HONO is formed during NO_x photolysis. The model correctly predicted data trends but quantitative agreements were poor for SO_2 and fair for NO_x. The process was effective at removing both SO_2 and NO_x, however; energy calculations indicate that more intense and efficient light sources than those currently available from commercial sources are required for the process to be viable. Preliminary data from a lamp development program indicate these specifications may be attainable.

A20

MODELLING THE PHOTOCHEMICAL DECOMPOSITION OF CHLORINATED PHENOLS BY SUNLIGHT. Nigel J. Bunce* and Jamie S. Nakai, Department of Chemistry and Biochemistry, University of Guelph, Guelph, Ontario, N1G 2W1.

The objectives of this work are to estimate the rates of photolysis of chlorinated phenols in the atmosphere, and to determine whether or not photolysis is a major atmospheric sink for members of this family of compound. The following information was obtained: solar photon flux (from tables); chlorophenol absorption spectrum as a function of wavelength (laboratory study); quantum yield of photolysis (laboratory study). As an approximation, quantum yields were considered to be independent of wavelength. Laboratory measurements of quantum yields of photolysis range from a low of 0.018 (pentachlorophenol) to a high of 0.45 (2-chlorophenol). Because the overlap between the solar tropospheric spectrum and the chlorophenol absorption spectrum is greater for the more heavily chlorinated congeners, the estimated rates of solar photodegradation are highest for the highly chlorinated congeners (e.g. 6% per hour for pentachlorophenol in summer compared with 0.002% per hour for 4-chlorophenol in winter). The measurement of these quantum yields has involved new methodology, and the extent to which surface processes interfere with the gas phase quantum yield determinations has been explored by the use of a mathematical model. The photolysis rates have been compared with the rates of reaction of these same substances with hydroxyl radicals. The latter reaction also depends on the solar photon flux because a major source of the hydroxyl radical derives from the photolysis of ozone, which absorbs in the same spectral region as the chlorophenols. A computer model is under development to assess the relative importance of these two processes. 2-Chloro-, 4-chloro-, and 2,4-dichlorophenol react principally with OH, but 3-chloro-, 3,4-dichloro-, 2,4,5-trichloro-, and pentachlorophenol react comparably quickly by both routes.

SESSION A

AIR QUALITY RESEARCH

Poster Presentations

AP1

STOCHASTIC MODELLING OF DISPERSION FROM SINGLE ELEVATED SOURCES. E. Robertson and P.J. Barry, Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario, KOJ 1JO

A stochastic model of plume dispersion has been developed to predict the frequency distribution of concentrations of gases released from a single isolated stack. The basic code performs Monte-Carlo simulations with variable input meteorological data fed to a standard Gaussian plume dispersion equation. The model has previously been validated for one site using concentrations measured at four locations within 6 km of the stack and meteorological data measured on site and also from a nearby Environment Canada network meteorological station. In the first case the stability was estimated from wind speed and vertical temperature gradients while in the second it was estimated using the STAR program. In both cases the long term mean concentration prediction was within a factor of two of measured values. The predicted and observed frequency distributions also agreed within a factor of two. The present program is to extend model validation to other sites in Ontario with varying terrain using archived concentration, meteorological and emission data (e.g. Sudbury). Model validity will be checked using several methods to estimate atmospheric stability and for a range of averaging times.

AP2

FEASIBILITY STUDY FOR ASSESSING AND MODELLING MICROCLIMATIC CONDITIONS ON THE FONTHILL KAME (PHASE I). Dr. Tony B. Shaw, et al, Brock University, St. Catharines, Ontario, L2S 3A1

The Fonthill Kame, located in the Town of Pelham, is the most important tender fruit area above the Niagara Escarpment. The steep slopes of the Kame, projecting above the surrounding flat plain, facilitate the drainage of cold air under radiation frost conditions. The mixing of cold surface air with warmer air above moderates the temperature near the ground and thus helps to reduce the risk of freezing damage. The distinct microclimate of the Fonthill Kame together with its well-drained soils make this area unique for the production of tender fruits. Since the microclimate of the Fonthill Kame is to a large extent related to its topography, it is argued by some that structural changes to the topography of the Kame, such as from sand and gravel extraction, will modify this microclimate. A modified climate may impact adversely on tender fruit crops on the Kame itself with possible consequences for areas contiguous to it. This study presents essential land use, physiographic and climatological background information on the Kame. It recommends ways in which the unique microclimate of this area can be better understood so as to assess the impacts of the multiple and competing land uses found here. The chief concern is with the disruption on cold-air drainage and the resultant effects on the temperature of the slopes and nearby off-site areas. Accordingly, the principal objectives of this study are, firstly, to determine whether methodologies exist for assessing changes to the Fonthill Kame's microclimate stemming from topographic modifications and, secondly, to evaluate the predictive capabilities of these methodologies for assessing the impact on the microclimate of future proposals for extraction on the Kame. The study reviews and recommends three methodologies. Two are empirical field study methods (surface-based and aircraft-based) and the third is a conceptual, numerical modelling approach.

AP3

CRITICAL EVALUATION OF ATMOSPHERIC POLLUTANT PARAMETERIZATION FROM SATELLITE IMAGERY.

N. T. O'Neill*, A. Royer, L. Hubert, CARTEL, Université de Sherbrooke, Sherbrooke, Qué.,
J. R. Miller, J. Freemantle, CRESS, York University, Downsview, Ont.,
Geoffrey Austin, A. Davis, McGill University, Montréal, Qué.

In spite of overwhelming advantages in spatial samping density and spatial coverage the remote sensing of atmospheric constituents represents a monitoring methodology which is often more qualitative than quantitative. The sensitivity of existing techniques for the inversion of satellite imagery data is not well understood in terms of discriminating constituent types and threshold levels of detection. The objective of the present study was to simulate the atmospherically scattered signal received by a satellite sensor and hence to evaluate the sensitivity of this signal to atmospheric aerosols in general and to atmospheric pollutants in particular. The investigation includes (i) an analysis of existing radiative transfer models in terms of speed and accuracy (ii) evaluation of the optical and physical parameters which can realistically be measured from the current generation of satellite sensors (iii) analysis of the specificity of the optical and physical information with respect to particular atmospheric pollutants (iv) threshold analysis with respect to the minimum detectable concentration of pollutants and (v) effects of surface concentration and altitude profile changes. Findings to date indicate that information on the vertically integrated contribution of sulfates, water vapour and carbonaceous soot can be usefully extracted. Inasmuch as the dominant optical variations occur in the atmospheric boundary layer this extracted information is typically correlated with ground level measurements. The specificity of the inversion technique (e.g. for extracting nitrate concentrations) can only be improved by exploiting high resolution spectral data and increasing the calibration/radiometric precision of satellite sensors. The simulation analysis was sufficiently promising to warrant a program of simultaneous ground based, airborne and satellite measurements as a subsequent phase to the present work. This program should include as well the acquisition and analysis of high spectral resolution airborne data to address the specificity problem. In the long term this type of research is geared towards the development of an operational satellite monitoring system within the context of the long range transport of atmospheric pollutants (LRTAP) programs.

AP4

A 3-D MESOSCALE WIND FIELD MODEL AND ITS APPLICATION FOR EMERGENCY PLANNING AT NUCLEAR POWER PLANTS IN ONTARIO

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The Ontario Ministry of Environment in collaboration with Ministry of Solicitor General, Ontario Hydro and Environment Canada, has developed an emergency plan for nuclear power plants in Ontario. Meteorological forecasts and dispersion modelling are an intergral part of this plan.

The distribution of winds in a shoreline environment, where all the nuclear power plants are situated is generally non-uniform and difficult to forecast. Mesoscale forecasts based on large scale synoptic maps are subjective and are demanding on the forecaster's skill. In order to assist the forecaster in analysing the wind field and to provide better input into dispersion models, the OME 3-D wind field model was modified and setup for the Pickering and Darlington Nuclear stations.

This paper presents results of this wind field model and its evaluation plan with the data obtained from the mesoscale wind measurement study currently being carried out jointly by AECB (Atomic Energy Control Board) and AES (Atmospheric Environment Services). In addition to the comparison between observed and forecast winds, model results from selected case studies are also presented showing the capability of the model in simulating the development of lake breeze in Pickering and Darlington area.

AP5

THE RESULTS FROM A MESOSCALE MODEL

BY

M. NIEWIADOMSKI

An atmospheric mesoscale model was developed to simulate the meteorological fields within a scale 0-300 Km. The model includes cloud physics and cloud chemistry. The paper discusses the results obtained in applying the model for typical situations. Also discussed is the method to integrate the model with the larger scale Eulerian long range transport model (ADOM).

AP6

DOSE RESPONSE FOR SELECTED ENVIRONMENTAL AIR POLLUTANTS: RESULTS FROM A STUDY ON RUNNERS. R.B. Urch*, F. Silverman, P. Corey and R.J. Shephard, The Gage Research Institute, Toronto, Ontario M5T 1R4

People running in an urban environment may be at greater risk to adverse health effects of inhaled pollutants since their ventilatory rate is increased, thus increasing the dose of pollutants that they are exposed to. This study examines health effects of air pollution on runners during training runs in downtown Toronto from 1986-1988. Subjects are selected from the Longboat Roadrunners Club which carries out weekly training runs covering an area in downtown Toronto and along the Lakeshore corridor during rush hour. There are two groups of runners, a 10 km and 17 km group. Pulmonary function (forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) and forced expiratory flows) and an oxygen rebreathing estimate of carboxyhaemoglobin concentration (COHb%) are measured before and after training runs; individual performance, subject evaluations, respiratory symptomatology and other health/illness information are also obtained. Pollutant measurements including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and respirable suspended particulate matter (RSPM), along with environmental covariates (temperature, humidity) are made using portable multipollutant samplers carried on bicycles following the runners (mobile personal samplers); one bicycle follows the 10 km group of runners while the other follows the 17 km group. Pollutant data is supplemented by Ministry of Environment data at central locations. Using only NO_2, SO_2, CO and RSPM with FVC, FEV_1, eye irritation, sore/dry throat and COHb%, no relationship between estimates of exposure and 1) pulmonary function or 2) symptoms have been uncovered in a preliminary analysis. The estimates of exposure will be improved by 1) taking into account the run distance and 2) using the product of the individual's respiratory ventilation rate, run time and pollutant concentration to calculate the pollutant dose.

AP7

HAMILTON AIR: CHEMICAL COMPOSITION AND GENOTOXIC ACTIVITY OF RESPIRABLE PARTICULATE AND ORGANIC VAPOURS. D.W. Bryant, C. Kaiser-Farrell and D.R. McCalla, Dept. of Biochemistry, McMaster University, Hamilton, Ont. L8S 4E1.

Polycyclic aromatic hydrocarbons (PAH) and their derivatives are formed in a variety of combustion and atmospheric processes and are found adsorbed to respirable particulate matter in air. Many of these compounds are known to be genotoxic (i.e. mutagenic and/or carcinogenic). Much work remains to be done to identify the individual components and to assess the genotoxicity and impact on human health of these complex mixtures. Additional genotoxins may occur in the vapour phase. The MOE is in the process of identifying environmentally important PAH marker compounds with a view to establishing a standard for air monitoring. The objective of this research is to examine the occurrence of PAH and their derivatives as a function of season and of weather conditions in an atmosphere dominated by emissions from primary and secondary industry and to compare these results with data obtained from business, residential and rural environments. Our concern is that any standards for PAH monitoring reflect the biological hazard. Our methodology is adapted from an extensive study of the mutagenic constituents of the atmosphere of a local steel foundry in which workers were clearly at an elevated risk for lung cancer. Initially, samples of Hamilton air particulates were collected on teflon/glass fiber filters either by means of standard hi-vol samplers or with size selective hi-vol samplers (PM 10). Filters were extracted sequentially with dichloromethane and methanol and the extract fractionated using a series of chromatographic steps. Fractions were subjected to mutagenicity assays using the Ames Salmonella/S9 procedure. A pooled sample from hi-vol filters (representing 360,000 cu. m of air) was collected during May, 1988,- a period characterized by frequent thermal inversions. The level of mutagenic activity seen in the presence of S9 (i.e. with metabolic activation) was over 30 revertants/cu. m which is high relative to many other urban centers and the mutagenic activity was concentrated in the PAH and oxy-PAH fractions of the extract. Preliminary chemical analysis of some of these fractions showed unequivocally the presence of certain PAHs. These appear to be generally similar to the classes of compounds detected previously in our steel foundry study. We are continuing to analyze this and other samples for activity in bioassays for the direct detection of DNA adducts in exposed bacteria and rabbit tracheal cells. Methods for the collection and bioassay of vapour phase organic compounds are also under investigation.

AP8

MUTAGENICITY STUDIES AND RISK ESTIMATION OF COMPLEX MIXTURES OF ORGANIC AIRBORNE CONTAMINANTS. A.S. Raj and D.M. Logan, Dept. of Biology, York University, North York, Ontario. M3J 1P3.

Natural atmospheres contain a complex variety of chemical contaminants, many of which have been implicated as mutagens and/or carcinogens. While the activity and hence associated risk of individual components can be assessed in a variety of short term biological tests, the risk due to complex mixtures is much less easily determined. The basic problem in such cases is that the components may react in several different and unpredictable ways. Our initial approach to this problem has been to examine several PAHs and halogenated hydrocarbons which are common atmospheric contaminants. The biological effect of each in two bio assays (The Ames and Micronucleus assays) is determined followed by measurement of the biological effects of defined mixtures. From such data we are beginning to develop some basic principles of the interaction of these chemicals. For example, when tested alone Benzo (a) pyrene [BaP], 7,12 - Dimethyl benz (a) anthracene [DMBA], and dibenz (a h) anthracene [DBA] are mutagenic in both assays, benzo (b) fluoranthene [BF] is negative in both and 1 nitro pyrene [NP] is negative in the bone marrow assay and positive in the Ames assay. In combinations, in contrast, the data are significantly more complicated. For example, in the Ames Assay (with strain TA 98), the effects of BaP and DMBA together are additive, BaP and NP are synergistic. When all three are tested together the response shows a much higher synergism than that with DMBA and NP alone. When the same mixtures are tested with TA 100 both synergistic responses are reduced to simply additive. Similar results have been obtained with other PAHs including clear examples of inhibition of response. Based on these data we propose several basic principles of PAH interactions in biological assay systems.

AP9

IN SITU MONITORING OF THE ENVIRONMENT FOR GENOTOXICITY LEVELS USING RODENTS. M. Petras*, M. Vrzoc, S. Meddins, K. Hill and T. Sands. Department of Biological Sciences, University of Windsor, Windsor, Ontario N9B 3P4

Contamination of the environment with a plethora of genotoxic agents has led to the need for a MONITORING SYSTEM which would provide an EARLY WARNING for changes in general environmental GENOTOXICITY. Towards this end two procedures have been examined: the SISTER CHROMATID EXCHANGE (SCE) TEST on bone marrow tissue; and the MICRONUCLEUS (MN) ASSAY on peripheral erythrocytes. Both assays are sensitive to a wide range of genotoxicants and both have been modified so that adequate sized samples can be examined. The organism of choice was the wild house mouse (Mus domesticus). However, laboratory strains of Mus, deermice (Peromyscus maniculatus) and meadow voles (Microtus pennsylvanicus) have also been examined. The results of these two assays were not affected by the ages of the animals, their genetic heterogeneity nor the short term stress to which the animals were subjected during exposure procedures. Determinations of SCE levels in mice from different southwestern Ontario samples revealed both geographic and seasonal patterns. Five years of data indicate a distinct association between these patterns and industrial pollution and farming practices, respectively. Similar patterns were not, however, seen with the MN assay. For both tests, multiyear baseline values have been established. These should prove valuable for future comparisons. Other aspects to be discussed include: results with known and suspected mutagens, monitoring of industrial sites, attempts to increase the sensitivity of the tests and correlation between the incidence of pulmonary, hepatic and gastric lesions and SCE levels in wild mice. In conclusion, the results indicate that the SCE assay can be used for in situ monitoring of environmental genotoxicity but the MN assay, which appears less sensitive, may be useful only in severe exposures.

[Supported by Ontario Ministry of the Environment.]

AP10

METHOD DEVELOPMENT FOR THE MONITORING AND ANALYSIS OF ODOROUS ORGANICS IN AMBIENT AIR. C.C. Chan*, L. Vainer and J.W. Martin, Mann Testing Laboratories Ltd., Mississauga, Ontario L4Z 1P1; A. Szakolcai and B. Foster, Ministry of the Environment.

In recent years, many air pollution complaints have involved odorous organic emissions. These malodorants are usually discharged into the air from a variety of municipal, industrial and agricultural activities. Nuisance caused by these activities can be attributed to four compound classes: aldehydes and ketones, amines, low molecular weight fatty acids and sulfur contaning compounds. These compounds are generally present in ambient air at very low concentrations, but due to their low odour thresholds, they are readily detected by the olfactory system. Unfortunately, the ultra low determination of these odorous organics has been hampered by the lack of reliable sampling systems and sensitive instrumentation. In addition, many offensive odour compounds are highly reactive and their ambient concentrations are usually too low for determination by direct analysis. This paper describes the progress of an in-depth development project to establish reliable sampling and analytical methods for odorous compounds at sub parts per billion levels. The sampling and analytical procedures will be developed separately, while keeping the complete sampling system in mind. Several methods are examined in this work which include: adsorption on a solid sorbent followed by thermal or solvent elution; collection on absorber with suitable reagent and analysis by gas or liquid chromatography; use of impregnated sorbents for collection by canister followed by concentration and analysis. Our overall strategy is to develop simple methods that give prompt results with good accuracy and precision.

AP11

GAS PHASE ANALYSIS OF ORGANIC COMPOUNDS FROM STRUCTURAL DOMAIN MODULATION WITHIN FLUORESCENT LIPID MULTILAYERS.

U.J. Krull*, R.S. Brown, and K. Stewart, Chemical Sensors Group, Department of Chemistry, Erindale Campus, University of Toronto, 3359 Mississauga Road North, Mississauga, Ontario, Canada L5L 1C6

Lipid membranes have been shown to be sensitive transducers of selective binding interactions when used in an optical fluorescence mode for chemical sensor development. Interaction of "receptors" with analytes can modify the fluorescence of the "receptor" or of a membrane-intrinsic optical probe. The utility of this latter analytical method stems from a generic process of signal generation based on a physical perturbation of membrane structure by a selective interaction. A physical alteration of the environment of fluorophores embedded within a lipid matrix is characterized by variations in fluorescence intensity, wavelength and lifetime.

Amplification of the analytical signal from a fluorescent lipid membrane would be improved if the physical structure of the lipid matrix containing the fluorophore could be greatly altered by a selective binding process. This form of amplification would be maximized by a phase transition which was induced by the binding event.

The waveguiding action of multilayers of lipid membranes of total thickness slightly greater than the wavelength of light being transmitted provides a matrix for efficient excitation of fluorescence for observation of changes of membrane structure induced by selective binding processes. This work reports the results of fluorescence studies of microscopic phase structures (domains) within lipid multilayers, and the modulation of such structures by selective and non-selective interactions with various organic species in the gas phase. The fluorescence variations associated with domain manipulation can be used to provide sensitive quantitative measurements of the partial pressures of various gas phase organics.

AP12

ATMOSPHERIC MEASUREMENTS OF NATURAL HYDROCARBONS USING GAS CHROMATOGRAPHY/MASS SPECTROMETRY.

H. Niki* and B.H. Khouw, Chemistry Department and Centre for Atmospheric Chemistry, York University, North York, Ontario M3J 1P3

A 3-year project has been initiated, as part of the Eulerian Model Evaluation Field Study, to obtain data for a number of key volatile organic compounds (VOC), particularly biogenic VOC such as ethylene, isoprene and mono-terpenes, which are needed for an assessment of the relative importance of NO_x and VOC, and natural vs. anthropogenic VOC in the oxidant and acid rain problem. At present, no data exist on biogenic VOC in a Canadian setting. High-resolution gas chromatography in combination with sample preconcentration methods is being employed by researchers in other countries for analysis of natural VOC. However, there is still a lack of well-established sample collection and preconcentration techniques which allow measurements of a wide range of these labile VOC on a routine basis with adequate precision, sensitivity and selectivity. A critical, comparative evaluation of existing sample - handling methods, i.e. cryogenic collection - preconcentration and adsorptive sampling - thermal desorption, for GC/MS analysis of these VOC is underway as a prerequisite for the planned field measurements. Also, to enhance data acquisition speed and quality, a fully automated preconcentration - injection system is being developed as a reference sample handling device for the GC/MS analysis. Begining the summer of 1988, samples collected at the Ministry's site at Dorset and other forested areas will be analyzed to obtain an annual data set mainly for natural VOC.

AP13

UTILIZATION OF ESTABLISHED AIR POLLUTION MONITORING NETWORKS IN ONTARIO FOLLOWING NUCLEAR INCIDENTS.

J.A. Slade* and G. Laszlo, Radiation and Industrial Safety Branch, Atomic Energy of Canada Limited, Chalk River Nuclear Laboratories, Chalk River, Ontario K0J 1J0

This preliminary study, funded by the Ontario Ministry of the Environment, investigated the potential of using charcoal-loaded filter paper in conventional high volume (HiVol) sampling networks for monitoring of radioactive iodine fission products following nuclear incidents. Four suppliers of suitable charcoal-loaded filter paper were identified. From these suppliers, eight media types were chosen for evaluation. Samples were tested for CH_3I and I_2 retention in an environmental chamber under controlled conditions. The parameters varied in the study were adsorbate concentration, challenge gas face velocity, relative humidity, and temperature. The study confirmed that a suitable charcoal-loaded filter paper media for environmental monitoring of radioiodines must employ chemically impregnated activated charcoal to retain organic iodines. Non-impregnated media was found to retain less than 0.2% CH_3I. Practical considerations regarding using charcoal-loaded filter paper for environmental radioiodine monitoring (sampling media configuration, radioiodine detection and measurement, and media shelf life) are also presented.

AP14

A RE-EXAMINATION OF ONTARIO'S 24 HOUR AMBIENT AIR QUALITY CRITERION FOR HYDROGEN FLUORIDE. R.D. Jones* and D.S. Harper, Ontario Ministry of the Environment, Air Resources Branch, Phytotoxicology Section, 880 Bay Street, Third Floor, Toronto, Ontario, M5S 1Z8

Ontario's proposed 24 hour ambient air quality criterion of 0.86 ug/m^3 for gaseous hydrogen fluoride was established in 1974. It was based on vegetation response studies available in the scientific literature at that time. Since then there has been concern expressed that this criterion was too stringent. In response, a criterion review project was established at the Ministry of Environment, Phytotoxicology Section, Controlled Environment facility at Brampton. Three plant species were exposed under controlled environment conditions to hydrogen fluoride gas at concentrations between 0 and 12 ug HF/m^3: Manitoba maple (Acer negundo), apricot (Prunus armeniaca) and "Snow Princess" variety gladiolus (Gladiolus sp.). Only gladiolus displayed measurable amounts of injury at 0.86 ug/m^3 after continuous 24 hour fumigations. Apricot and Manitoba maple did not develop injury at concentrations below 1.0 ug HF/m^3. Consequently it is recommended that the existing proposed ambient air quality criterion be adopted as an air quality standard. Unlike other air quality standards there is no apparent safety margin. The very slight injury observed at the lowest doses, and, the probability that plants growing in outdoor (natural) environments would not respond as sensitively, are considered to create a safety margin.

AP15

PRODUCTION OF OZONE-INSENSITIVE WHITE BEAN VARIETIES.
Department of Crop Science, University of Guelph, Guelph, Ontario N1G 2W1. Thomas E. Michaels.

White bean is among the most ozone-sensitive crops in southwestern Ontario. Heritable differences in ozone sensitivity have been found among common bean cultivars, suggesting that insensitive cultivars could be developed. A breeding program to develop ozone-insensitive cultivars at the University of Guelph is nearing completion. Forty breeding lines and eight check varieties that were previously screened indoors for ozone sensitivity at the seedling stage were planted at Woodstock, Ontario in 1987 for additional ozone sensitivity screening and yield evaluation. Two breeding lines were both significantly higher yielding and more ozone insensitive, but later maturing, than the best performing white bean check cultivar, Ex Rico 23. The breeding line with the least leaf area damage based on indoor screening also showed low ozone injury in the field, and had numerically higher yield and equivalent maturity to Ex Rico 23. Seven of the breeding lines were entered in advanced trials in 1988 at two locations. The best line will likely be entered into the Ontario Field Bean Variety Trials to determine merit for Canadian variety registration.

AP16

EFFICACY OF FILM-FORMING CHEMICALS FOR PROTECTING ROADSIDE TREES AGAINST SALT SPRAY. Calvin Chong, Ministry of Agriculture and Food, Horticultural Research Institute of Ontario, Vineland Station, Ontario LOR 2E0

In November 1987, selected branches of peach trees located along a major highway were left unsprayed (control), covered with burlap, or sprayed with five chemicals (Folicote, RD# 1725, RD#1726, Siliconate, Joncryl 38). By spring of 1988, control twigs accumulated 385 ppm Cl^- and showed the greatest twig dieback (13.6 cm to first flower bud). In contrast, burlapped twigs accumulated only 58 ppm Cl^- and was least injured (5.3 cm dieback). Corresponding data for spray-treated twigs were intermediate indicating small to moderate beneficial influence of most sprays, especially RD#1726 (278 ppm Cl^-; 8.7 cm dieback) and Joncryl 38 (248 ppm Cl^-; 7.4 cm dieback). The above spray treatments were ineffective when similarly applied to six woody coniferous and deciduous species. In another study, whole peach trees were similarly sprayed with Folicote, RD#1725 and four new emulsion-based formulations (RD#2034, 2035, 2036); half of each tree was sprayed several times during the winter with a 2% salt solution. RD#2033 treated twigs showed the least injury and accumulated moderately less Cl^- than the control twigs from both salted and non-salted side of trees. All other treatments were ineffective and, in fact, RD#2034 treated twigs accumulated more Cl^- and Na^+ than the control and had the greatest amount of injury. This project is a joint cooperative study of the Ministries of Agriculture and Food, Transportation, and Environment.

AP17

AN EVALUATION OF THE PROBLEMS OF PARTICULATE EMISSION FROM THE WOOD PRODUCTS INDUSTRY. Michael F. Lepage and Anton E. Davies, Rowan Williams Davies & Irwin Inc., 650 Woodlawn Road West, Guelph, Ontario, N1K 1B8.

An evaluation of problems of fugitive particulate emissions in the wood products industry was conducted on behalf of the Ontario Ministry of the Environment (MOE). The objectives included identifying the problems and their sources, determining how industry and regulatory agencies other than the MOE treat the problems, providing recommendations to resolve the problems, and providing guidelines for an improved approvals process, improved monitoring of wood particulate and proper manangement of wood products facilities. These objectives were achieved by conducting a literature search, an extensive telephone survey and two field trips. Among the results of the study were a review of the health effects and other problems associated with wood dust emissions, a detailed description of the sources, a review of dust control technologies currently used in the industry, and a review of monitoring and permitting practices among government agencies. Recommendations of the study included setting emission standards for fugitive sources, requiring certain fundamental dust control practices at all facilities, use of scale model dispersion modelling to determine the need for additional controls, and improved correlation of wind data with particualte monitoring data to pinpoint the primary emission source in a multisource region. Further research was recommended into emission factors for the wood products industry and to develop an improved dustfall collector.

AP18

RELATIONSHIP OF SUGAR MAPLE DECLINE AND CORRESPONDING CHEMICAL CHANGES IN XYLEM SAP CARBOHYDRATES, MICRONUTRIENTS AND TRACE ELEMENTS. S.N. Pathak*, T. Hutchinson and D.N. Roy, University of Toronto, Department of Forestry, 203 College Street, Toronto, Ontario M5S 1A4.

The study focuses on the variability of certain significant chemical components in sap and stem matrices of sugar maple trees and their degrees of decline. This systemic chemical data is not available in the literature and is not covered by other studies currently in progress at the MOE and the IES, University of Toronto. It is presumed that if environmental factors have interfered with the biological processes of a normal maple tree then it would reflect on the xylem sap carbohydrates, micronutrients and trace elements as well as in the major chemical components of the stem tissue. Five sample plots established by MOE were chosen for site studies. Early (March) and late (April) season sap were collected aseptically from these sites. Samples were analysed for micronutrients and trace elements by ICAP. Preliminary analysis of 24 elements shows that there is a trend of increasing amounts of Al and Mn and decreasing amounts of Ca, Mg, P, and Fe, when healthy trees were compared with declining maple trees. The levels of S remain unchanged. Levels of Na and K are being analysed by Atomic Absorption Spectroscopy. Mono-, di- and oligo-saccharides in the sap are being investigated by Ion Exchange Chromatography (Dionex) which offers a very high resolution for quantitative determinations (30-100 ppb). The method has been standardized and provides highly reproducible results. It further eliminates the uncertainties associated with existing methods of carbohydrate determination. Some early results and trends will be presented. To provide secondary support for the carbohydrate determination, refractive indices of the samples have been recorded for gross estimation. Work on stem matrices will be undertaken later. Compilation of data of all the above variables might provide indication of biological discurbances and corresponding chemical changes taking place in declining sugar maple trees.

AP19

IDENTIFICATION OF LONG RANGE AEROSOL SOURCES AT THE DORSET ENVIRONMENTAL STATION. John Drake*, Abdul Kabir and Stephen Vermette, Department of Geography, McMaster University, Hamilton, Ontario L8S 4K1

The purpose of this study is to analyse and source airborne particulates at Dorset, Ontario by multi-element methods. Daily high-volume air filter samples were taken at the Dorset Environmental Research Station by MoE from May to August 1987. Instrumental Neutron Activation Analysis has been used to analyse for thirty elements. Clear and unambigous methods for the determination of the seven most important elemental tracers (Mn, V, In, Ar, Se and Zn), environmentally crucial elements (Al, Br, Ca, Cl, Cu, I, Na, Fe, Co and Cr) and other elements have been developed. Quality Control is ensured by analyzing very well known certified materials supplied by the U.S. National Bureau of Standards and International Atomic Energy Agency. Concentrations of the seven important tracers will be used to quantify North American, Ontario, European and Euroasian sources of pollution. Statistical treatment of the data will include enrichment factors (with regard to the crust and sea water), factor analysis, cluster analysis and elemental ratios.

SESSION B

WATER QUALITY RESEARCH

Oral Presentations

WATER QUALITY RESEARCH

Carl Schenk
Water Resources Branch
Environment Ontario

Research needs related to water and the aquatic environment cover a broad range of concerns and issues. The needs identified hereafter reflect the Ministry's interests in establishing improved treatment processes for the Province's drinking water supplies and the removal or neutralization of municipal, industrial and diffuse source wastes, developing a better understanding of cause-effect relationships in aquatic systems so that effort can be directed to deal more effectively with water quality impacts, and determining improved environmental evaluation techniques.

For convenience, water research requirements have been grouped into the following eight categories, involving 33 issues and about 130 specific needs:

1) Industrial Wastewater Treatment
2) Municipal Wastewater Treatment
3) Managing Non-Point Sources of Pollution
4) Contaminant Fate and Transport Processes in Aquatic Systems
5) Impacts of Pollutant Discharges on Aquatic Systems
6) Drinking Water
7) Effects of Acidic Deposition and Long Range Transport of Contaminants
8) Other

Research issues have been altered and the specific needs adjusted for fiscal year 1989-90 based on input from head office and regional staff throughout the Ministry. New issues include WA10 to investigate effects of intensive crop production practices on groundwater quality, WA14 to identify remedial measures to minimize the impact of lakeshore development, WA15 dealing with the aquatic effects of timber management practices, WA18 involving the development of models to address contaminant fate and transport in the Great Lakes, WA21 to model the impacts of contaminant discharges on aquatic biota, WA30 on the distribution, behaviour and effects of low level trace metals in aquatic systems, WA31 concerning the effects of organic contaminants associated with long range transport and finally, WA33 dealing with the spatial anayses of water quality.

Clearly, the Ministry's top priority in water research relates to evaluations of the significance of hazardous contaminants and minimization of these contaminants as a threat to our natural waters and drinking water supplies. This emphasis is reflected by the vast majority of the 33 research issues and related needs that have been identified. Studies carried out by universities and private sector consultants within the Ministry's environmental research program provide a substantial information base that contributes to the formulation of effective legislation, policies and workable solutions for resolving the numerous problems and concerns presented by hazardous contaminants in our aquatic ecosystem.

B1

AQUATIC BIOLOGY IN THE NEW REGULATORY FRAMEWORK;
K. Day, National Water Research Institute,
Burlington, Ontario.

SEE WATER QUALITY RESEARCH SESSION B PROCEEDINGS
BOOK FOR THE EXTENDED ABSTRACT.

B2

HYPOTHESIS TESTING IN AQUATIC TOXICOLOGY: QSAR Relationships and Simple Kinetic Modelling.

L.S. McCarty,**; G.W. Ozburn*; and A.D. Smith*

* Aquatic Toxicity Research Group, Lakehead University, Thunder Bay, Canada, P7B 5E1
* Biology Department, University of Waterloo, Waterloo, Canada, N2L 3G1.

This paper reviews some of the explicit and implicit assumptions of commonly employed aquatic bioassays where toxicity and/or bioconcentration are estimated. For many organic chemicals the link between bioconcentration-derived and toxicity-derived kinetic information, as well as the hypothesis that typically employed biological endpoints occur at relatively constant body burdens, can be exploited by means of a one-compartment, first-order kinetics model.

The model, when verified for the mode of toxicity and the general character of the test species, can be used to explore situations not explicitly examined in the original data. The applicability of such an approach for regulatory purposes is discussed. The use of such deterministic models to formulate hypotheses to direct experimental designs for future testing is another important aspect, especially as much aquatic toxicology testing has not been driven by the standard scientific approach of hypothesis formulation and testing. Examples of applications dealing with mixtures of toxicants, intermittent exposure regimes, and the influence of substantial differences in body size are discussed.

B3

VARIATIONS IN THE RESPONSE OF FISH POPULATION CHARACTERISTICS TO ENVIRONMENTAL CHANGES. K.R. Munkittrick* and D.G. Dixon, Department of Biology, University of Waterloo, Waterloo, Ontario N1L 3G1.

There is a need to develop simple and inexpensive methods to follow fish population responses to environmental degradation or lake restoration. The status of fish populations is a reflection of the overall condition of the aquatic environment, and over the past four years we have adapted a framework which uses fish population characteristics as indicators of environmental health. The framework was originally adapted using populations of white sucker (Catostomus commersoni) and is entitled Population Indicators of Sublethal Contaminant Effects on Suckers (PISCES). PISCES originated as a modification of a description of fishery impacts on fish populations and divides populations into five response patterns based on characteristics such as mean age, fecundity and fish condition. The most widely recognized response pattern corresponds to direct effects on adults and changes parallel the response of fish populations to fisheries exploitation. Using published data, PISCES has predicted the responses to changes in predation pressure, acidification, eutrophication, and the impacts of mine waste and reservoir impoundment, using a wide variety of species. When changes were not correctly predicted, the use of the contrasting, generalized patterns directed and focused research efforts on crucial aspects impacted by changing conditions. The program is dependent upon the selection and appropriate sampling of a comparable, reference population although several alternatives may be available.

B4

AN EXAMINATION OF CHRONIC TOXICITY OF THIOCYANATE TO FRESHWATER FISH FOR THE DEVELOPMENT OF A WATER QUALITY CRITERION. D.G. Dixon, R.P. Lanno* and S.D. Kevan, Dept. of Biology, University of Waterloo, Waterloo, Ontario, N2G 3L2.

Thiocyanate (SCN^-) is a major component in the process of cyanide detoxification of mining waste. The goal of our research is to obtain sufficient data on the chronic toxicity of SCN^- to develop a water quality criterion. No observed effect concentrations (NOEC) for continuous exposure of juvenile rainbow trout and all life stages of fathead minnow, as well as pulse-exposure NOEC for rainbow trout eggs, sac fry and juveniles, will be established. Juvenile trout, continuously exposed to 40, 80, 120 or 160 mg SCN^-/l for four months, showed increased mortalities and plasma SCN^- levels, decreased food consumption, growth, hemoglobin, hematocrit and liver and splenosomatic indices. Varying degrees of behavioural anomalies, transient pigmentation changes, cranial deformities and pale, friable livers were also noted. Rainbow trout eggs exposed to a 3 h pulse-dose of SCN^-, either before or after water hardening, showed decreased survival and fertilization rates and increases in the numbers of embryonic deformities at the highest levels of SCN^- exposure (1440 and 2880 mg/l). Upon completion of the laboratory studies, an attempt wil be made to apply some of the biochemical indicators of SCN^- toxicity in a field situation. White suckers will be sampled from waters receiving a SCN^--bearing effluent in the Hemlo gold mining region of northern Ontario to assess the impact of SCN^- on feral fish populations.

B5

POTENTIAL ROLE OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE DEVELOPMENT OF LIVER TUMORS IN FISH FROM POLLUTED SITES OF LAKE ONTARIO.

G.M. Kirby, I.R. Smith, C. Thorn, H.W. Ferguson and M.A. Hayes, Fish Pathology Laboratory, University of Guelph, Guelph, Ontario N1G 2W1

Various liver tumors occur with increased frequency in several species of bottom-dwelling fish inhabiting locations with industrially polluted sediments. In white suckers *(Catostomus commersoni)* from the Hamilton Harbour region of Lake Ontario, preneoplastic and neoplastic liver and bile duct neoplasms are well recognized but are much less prevalent in white suckers from less-polluted control sites in Lakes Huron and Simcoe. Polyclonal antiserum prepared against purified hepatic glutathione S-transferases (GSTs) from white suckers was used for immunocytochemical demonstration of GST expression in the various liver lesions in white suckers. GSTs are considered to be important in detoxification of polycyclic hydrocarbons (PAHs) and diminish the mutagenicity of benzo(a)pyrene (BaP). All liver tumors were GST-deficient in comparison with surrounding non-neoplastic liver. Also, these fish had few early preneoplastic foci compared with advanced liver tumors. White suckers from the Hamilton region had faster rates of biliary excretion of BaP than fish from clean sites in Lake Huron. These findings suggest that environmental mutagenic chemicals such as PAHs, which can be normally detoxified by GSTs in these fish, may play a role in the malignant progression of the GST-deficient neoplasms.

B6

PLANT BIOASSAYS FOR THE DETECTION OF ENVIRONMENTAL MUTAGENS IN AN AQUATIC ENVIRONMENT. W. F. Grant, Department of Biology, York University, North York, Ontario M3J 1P3

Various higher plant assays have been developed for the detection of airborne and aqueous mutagens. These assays are inexpensive, easy to handle and applicable to indoor as well as outdoor detection of environmental mutagens. Quantitative plant assays for the genotoxic detection of aqueous pollutants are relevant and useful in establishing water quality standards. We are developing such an assay for genotoxic aqueous pollutants using two higher plants, namely, Tradescantia, and Vicia faba. Each plant assay has different features for detecting gene mutations and/or chromosome aberrations. Tradescantia has two assay systems: the Stamen Hair Assay for the detection of gene mutations, and the Micronucleus Test for the detection of chromosomal aberrations. The Vicia faba assay system detects chromosomal aberrations in root tips. Floats of different shapes and capacities for holding plants have been designed for aqueous testing in different types of aquatic habitats (still, slow moving and fast running water). One float consisting of a 30 cm circular plexiglass disk, drilled with holes for holding the plants, with a ring of styrofoam surrounding the disk for buoyancy and a 60 cm plexiglass rod attached to the center of the disk for stability, has been selected as meeting all the requirements for successful experimentation. Field trials are in progress. Using these assays, we are also collecting data on the mutagenicity of a number of dyes used in the paper industry. Preliminary results indicate Basazol Orange and Red weakly mutagenic; Basazol Yellow and Rhodamine 6G induce chromosome aberrations; studies on Victoria Blue, Crystal and Methyl Violet are in progress. Results of ongoing studies with these dyes will be reported together with those of the field trials from potentially mutagenic polluted water sites.

B7

EFFECTS OF TEMPERATURE AND FIELD PROCEEDURES ON PCB BIOACCUMULATION IN ELLIPTIO COMPLANATA. Al Melkic and Yves Rollin, Integrated Explorations. P.O. Box 1385, Guelph, Ont. N1H 6N8.

Although fresh water clams have been used as in situ biomonnitors in Ontario for almost a decade little information is available on the effects of temperature and field handling methods which might affect PCB bioaccumulation capacities in clams.
An experiment was designed to investigate these potential efffects. Clams subjected to various experimental regiemes were simultanously exposed for 21 days to a common source of PCB contaminated water.

Clams of the species **Eliptio complanata** were exposed to water from the Niagara River at Niagara on-the Lake at various temperatures. The calms were held within environmental chamber systems on shore with continuously supplied river water adjusted to specific constant temperatures. Simultaneously, in situ experiments were conducted within the same water supply to determine the effects of different deployment techniques as well as methods of tranportation and tissue processing.

The results of these experiments, conclusions, and an overview of the proctical limitations of clam biomonitring will be presented.

B8

BIOMONITORING : CHEMICAL DEPENDENT QUANTITATIVE RELATIONSHIPS FOR THE BODY BURDENS OF ORGANIC CHEMICALS IN AQUATIC BIOMONITORS. Frank, A.P.C. Gobas*, R. Russell, G.D. Haffner; The Great Lakes Institute, University of Windsor, Windsor, Ont., Canada N9B 3P4

Data are presented from laboratory experiments in which the uptake and bioaccumulation of a series of hydrophobic organic chemicals (log Kow from 3 to 8.5) were studied in fish and in the fresh water mussel Eliptio complanata. These data are used to calibrate a model describing uptake kinetics and bioaccumulation after aqueous and dietary exposure as a function of the chemical properties and the organism's physiological characteristics. The resulting quantitative relationships between organism body burden and chemical concentrations in water and food were then tested in the field. Data from field experiments in Lake St. Clair are reported and shown to be consistent with the model predictions. It is concluded that the relationship between body burden and environmental concentrations is largely chemical dependent, and that results from monitoring studies have to be interpreted on a chemical by chemical basis. Procedures are presented for the calibration of biomonitors and the interpretation of biomonitoring data is discussed.

B9

BIOMONITORING PROTOCOLS FOR ADULT AQUATIC INSECTS: SEASONAL AVAILABILITY, SAMPLE SIZE AND SENSITIVITY. Z.E. Kovats and J.J.H. Ciborowski*. Dept. of Biological Sciences, University of Windsor, Windsor, Ontario, N9B 3P4

Benthic aquatic insect larvae living in contaminated sediments accumulate significant organochlorine burdens. However, their value as indicators is limited by sampling difficulties and the necessity of acquiring enough biomass for analysis. The nocturnal, photophilic, winged adult stages are more easily collected than larvae. Our objectives were to assess seasonal variation in adult insect availability and contaminant burden, contrast concentrations in animals from contaminated sites with those from uncontaminated areas, and determine minimum sample biomass that provides reasonable detection limits for organochlorine contaminants (PCBs, pesticides and others). Light trap collections yielded large samples of Trichoptera (mostly Cheumatopsyche) from late May to late August at sites on the Detroit and St. Clair rivers. Ephemeroptera (Hexagenia, Caenis) were abundant for only 1-2 weeks in midsummer. Midsummer collections yielded many Trichoptera at five sites along the Niagara River. However, low temperatures limited the size of catches of Trichoptera, Hexagenia and Caenis at four locations on the St. Mary's River. Contaminant concentrations in animals from Detroit River samples were typically 1-2 orders of magnitude greater than in animals from several central Ontario control sites. Series of triplicate subsamples of different mass from a single large collection were analysed for 30 organochlorine compounds. The proportion of contaminants at detectable concentrations and median coefficient of variation stabilized in samples $\geq$0.4 and $\geq$0.8 g dry mass for animals from contaminated sites and uncontaminated sites, respectively. Seasonal variation in contaminant concentration at sites on the Detroit and St. Clair rivers will be compared with spatial variation among major Great Lakes connecting channels.

B10

AN ECOSYSTEM APPROACH TO THE MONITORING OF PCB's IN PRISTINE ONTARIO LAKES

C.D. Metcalfe and C.R. Macdonald

A large proportion of the PCB's observed in the Great Lakes have been attributed to deposition from the atmosphere. The purpose of this study is to assess the role of atmospheric deposition in determining the concentration of PCB's in pristine lakes of the Haliburton-Renfrew County region of Ontario. Samples of zooplankton, benthos, 5 species of fish, water, suspended particulates, and sediments were collected in 1986, 1987, and 1988 from 7 lakes and analyzed by capillary column gas chromatography for concentrations of 20 selected PCB congeners. Within isolated lakes receiving atmospheric deposition of PCB's, all biota contained approximately the same levels of PCB's. Principle components analysis (SIMCA) of the PCB congener distribution in these lakes indicated a characteristic congener pattern, with a high proportion of lower chlorinated congeners. The observed distribution of PCB's in the various trophic levels of selected lakes was compared to theoretical levels calculated by the aquatic contaminants model WASTOX from the USEPA.

B11

METAL CONTAMINATION OF WETLAND FOODCHAINS IN THE BAY OF QUINTE, ONTARIO.A. Crowder*, W. Dushenko and J. Greig, Dept. of Biology, Queen's University, Kingston, Ontario K7L 3N6

Diversity and biomass of aquatic macrophytes diminished during hypereutrophication of the Bay of Quinte, Lake Ontario, during the 1960s and have not recovered. Numbers of waterfowl and mammals in wetlands in the Bay are also low. It was hypothesized that the wetlands are contaminated by metals derived from mines in the Moira Valley, compounding the stress of eutrophication. Possible contaminants analysed in samples of sediment have included Ag, As, Al, Cd, Co, Cl, Cu, Hg, Mg, Mn, Na, Ni, Pb, Ti, V and Zn. Nutrient concentrations in sediment were also measured (N, P, K, Ca and Mg). Elemental concentrations in emergent and submerged plants and in snails have been analysed, using neutron activation analysis and atomic absorption spectrophotometry, to test for transfer of contaminants up food chains. Cover classes of submerged plants at sites around the Bay were correlated with metals and nutrient concentrations, and also with limiting factors such as exposure and slope of shores, organic carbonates and silt content of sediments, and pH.

Significant differences occur between wetlands in the Moira River area and in Hay Bay, about 20 km east. Concentration of As, Co, Na, Mn and Pb are higher in Hay Bay. Concentrations of As (2.1-4.5 ppm), Cr (29.2-46.6ppm), and Cu (10.3-25.1 ppm) are potentially toxic, while sediment Hg is not (< 0.2 ppm). Submerged plants in the Moira area contain significantly higher concentrations of As and Mn (means 4.6-6.8 ppm As; 656-703 ppm Mn). One sampled snail species (Sphagnicola elodes)accumulates 34.93 $^{+}$- 12.44 ppm Cu. Concentrations of Mn and Al in snails are also elevated, but show high variance within species.

B12

AN OVERVIEW OF AQUATIC ENVIRONMENTAL RESEARCH IN QUEBEC;

M. Slivitsky, INRS-EAU, Ste. Foy, Quebec.

PAPER NOT AVAILABLE

B13

DEVELOPMENT OF AN IMPROVED SYSTEM FOR THE APPLICATION OF POWDERED ACTIVATED CARBON IN WATER TREATMENT PLANTS. H. Donison*, A. Benedek and J.J. Bancsi, ZENON Environmental Inc., Burlington, Ontario.

There is currently a general concern in Ontario about the quality of the drinking water, in particular, with the dangers of toxic organic contamination. As such, many communities are either already using or are proposing to use powdered activated carbon (PAC). The objective of this study is to develop process design criteria for application of PAC in drinking water treatment for removal of toxic organics contaminants and to develop an optimized PAC contacting system. Currently, the most common way of adding PAC is directly into the water stream after coagulant addition and before sedimentation. However a literature review and laboratory bench-scale studies have identified two PAC reactor systems which provide more effective PAC utilization and potentially better water quality. The two systems chosen for development are a packed PAC column and a multi-stage ultrafiltration system. Based on laboratory bench-scale studies and a pilot scale study a detailed technical and economic assessment of these processes will be carried out. Potentially the developed technology could be implemented in water treatment plant where organic contamination from spills or other sources is a concern. The technology base could also be used to develop a mobile system for emergency treatment of accidental contamination at sites across the province.

B14

MUNICIPAL UTILIZATION OF WATER DEMAND MANAGEMENT STRATEGIES IN ONTARIO MUNICIPALITIES. R.D. Kreutzwiser* and R.B. Feagan, Department of Geography, University of Guelph, Guelph, Ontario, N1G 2W1

Managing the demand for municipal water has become a viable alternative or supplement to traditional supply management. Senior governments in Canada are committed to the demand management concept, though use and promotion of water conservation strategies appear limited. This paper assesses the extent of municipal use of demand management across southern Ontario and examines factors which influence variation in use of water conservation strategies. Data derived through a mail-back questionnaire from 219 municipalities revealed little use of more powerful conserving strategies such as metered inclining rate structure or retro-fit water conserving devices. Daily peak-hour rate structure and limiting water distribution system pressure were not in use among any responding municipalities. Almost 80 percent, however, had at least some metering of use in place and over one-third made some use of a metered flat rate structure. Almost two-thirds had applied summer water use restrictions. A number of characteristics of municipal water supply systems and system managers were associated with variations in use of water conservation strategies; however, larger municipalities and those experiencing serious water system problems were most likely to make greater use of water conservation strategies.

B15

A PRELIMINARY STUDY TO DETERMINE THE FEASIBILITY OF MEDIUM PRESSURE MERCURY LAMPS FOR DISINFECTING LOW QUALITY WASTEWATERS. G.E. Whitby 1, G. Sakamoto 1 and G. Palmateer2* 1. Trojan Technologies Inc., London, Ontario, N6E 2S8 2. Ontario Ministry of Environment, London, Ontario N6E 1V3

The discharge of untreated combined sewer overflow (CSO) into recreational waters has become a major problem in North America. Studies show that ultraviolet light (UV) disinfection of CSO with low pressure mercury (LPM) lamps is possible but the capital cost is prohibitive. This study compared the LPM lamp to the medium pressure mercury (MPM) lamp which has a much higher UV output and this could decrease the capital cost. Raw, primary, secondary and mixtures of wastewaters were irradiated with the two types of lamps using the collimated beam method of Qualls and Johnson (Appl. Environ. Microbiol. 45: 872-877, 1983). Each type of wastewater required a different dose of UV light to reach a 3 log kill or 200 fecal coliforms per 100 mL because of the UV transmission, suspended solids and the relationship of the fecal coliforms with these particles. With these wastewaters each watt of UV light from the MPM lamp was equal to 3.6 watts from the LPM lamp when the UV light was measured with the same sensor. The above data and the measurement of the total UV output showed that one - 2000 watt MPM lamp was equal to 14.2 - forty watt LPM lamps. Flow rates could be calculated for each of the wastewaters. Depending upon the fecal coliform limit these flows varied between 116 and 522 litres per minute for the 2000 watt MPM lamp. The flow rates for raw effluent will be confirmed using a flow through reactor with three different water layers. This data will be used to prepare an economic analysis of UV disinfection of CSO with MPM lamps.

B16

Characterization of the Fecal Indicator Bacterial Flora of Sanitary Sewage with Application to Identifying the Presence of Sanitary Waste in Storm Sewers.

P.L. Seyfried*, T. Bleier, Y. Xu and R. Harmandayan, Department of Microbiology, FitzGerald Building, University of Toronto, Toronto, Ontario.

This study, sponsored by the Ministry of the Environment, investigated the use of specific bacteria to detect human fecal wastes in storm sewer lines. The organisms examined were fecal coliforms, Escherichia coli, fecal streptococci, enterococci, Pseudomonas aeruginosa, Clostridium perfringens, and Bifidobacterium sp. These bacteria were isolated during periods of wet and dry weather from surface runoff, from designated locations in sanitary sewer lines, and from priority and nonpriority storm sewers. Biochemical testing, serotyping, and/or genotyping were used to further characterize more than 4000 fecal streptococcus, Pseudomonas aeruginosa, and Bifidobacterium isolates. Speciation of the fecal streptococci showed that Streptococcus faecalis subsp. faecalis was more predominant in sanitary and high priority sewers than in surface runoff and nonpriority sewers. S. casseliflavus, on the other hand, was primarily found in runoff and nonpriority storm sewers. DNA sequence studies of the fecal streptococci, using Restriction Endonuclease Analysis (REA) produced many different patterns and it was difficult to establish any relationship between the isolates. By comparison, P. aeruginosa genotypes were more uniform and fewer patterns were observed. As an example, a specific P. aeruginosa genotype was isolated from both the street runoff and the storm sewer at one City of Toronto location. Genotyping also appears to be a good method of distinguishing between the Bifidobacterium sp. that are predominant in sewage.

B17

LANDSAT-5 TM SPECTRAL RESPONSES FOR LAKES ACROSS NORTHEASTERN ONTARIO. J. Roger Pitblado, Geography Department, Laurentian University, Sudbury, Ontario P3E 2C6

This three-year study represents an extension of M.O.E.-funded research initiated in 1986-87 to investigate the feasibility of using remotely sensed data for the determination of surface water quality characteristics of lakes in Ontario. Initial investigations were able to demonstrate that several water parameters could be predicted with confidence using satellite or airborne digital data and that gross differentiations between acidic and non-acidic lakes could be made in the Sudbury area. Previously developed multiple regression models and image analysis techniques are now being refined and semi-automated to extend the study to large portions of the northern part of the Province.

Currently, spectral responses acquired by the Landsat-5 Thematic Mapper instrument are being gathered for all water bodies larger than one hectare (if they are detectable by the satellite) in the area of Northeastern Ontario that extends from the North Channel of Lake Huron to Highway 11 (south-north) and from Wawa to Temagami (west-east), approximately 120,000 sq.km. Principal components of the seven TM channels have been determined and these, as well as the digital responses of the TM channels themselves, are to be associated with available field-collected water quality Characteristics. Because of the size of the study area and the necessity of using images acquired from different Landsat-5 passes, this study affords the opportunity of examining the problems associated with the employment of multidate imagery.

B18

RELATIONSHIP OF MERCURY LEVELS IN SPORTFISH WITH LAKE SEDIMENT AND WATER QUALITY VARIABLES. C.D. Wren, B.A.R. ENVIRONMENTAL, RR#3, Guelph, Ontario N1H 6H9.

The objective of this study was to examine the relationship between mercury levels in sportfish and mercury levels in lake sediments and lake physical and water quality variables. Mercury levels in fish were obtained from the MOE/MNR Fish Contaminant Monitoring Program. Sediment geochemical data were obtained from the Geological Survey of Canada. Tissue mercury levels in small mouth bass and walleye were weakly correlated with background sediment mercury levels. Mercury levels in lake trout were not correlated with background sediment mercury concentrations. Results suggest that mercury of geological origin does not account for differences in fish mercury levels between lakes. Mercury concentrations in standard size smallmouth bass and walleye were negatively correlated with water quality variables reflecting water hardness and acidity. Therefore, fish of these species in low pH lakes tend to have elevated mercury levels relative to circumneutral lakes. There was a very high correlation between standard mercury concentrations in smallmouth bass and walleye, and between smallmouth bass and lake trout. The development of interspecies correlations could provide a useful management tool.

B19

TREND ANALYSIS PROCEDURES FOR WATER QUALITY TIME SERIES

A.I. McLeod*, Dept. of Statistical and Actuarial Sciences, The University of Western Ontario, London, Ontario, N6A 5B9, K.W. Hipel and B. Bodo

The overall objective of the study is, to develop graphical and statistical trend analysis procedures for use with the water quality time series obtained from Ontario's Provincial Water Quality Monitoring Network(PWQMN). Trend analysis is required for alerting authorities about water quality degradation so that appropriate corrective action can be taken and evaluating the performance of pollution abatement schemes. In order to detect visually increasing or decreasing trends, a range of exploratory data analysis techniques are being applied to PWQMN data sets. The graphical methods include time series plots, box and whisker graphs and a smoothing technique called robust locally weighted regression. A special type of nonparametric test, closely related to the Mann-Kendall test, is being developed for rigorously testing for the presence of trends. This improved test will also be applied to PWQMN water quality time series.

B20

USE OF A BROMOBENZOATE FOR CROSS-ADAPTATION OF ANAEROBIC BACTERIA IN LAKE ONTARIO SEDIMENTS FOR BIODEGRADATION OF CHLORINATED AROMATICS. M. Urbanek*, T. Strycek, R.C. Wyndham and M. Goldner. Department of Microbiology, University of Toronto, Toronto, Ontario M5S 1A8

The cycling of carbon compounds in freshwater ecosystems depends upon a balance being maintained between the synthesis of organic compounds and their degradation. This equilibrium is threatened by the discharge of potentially persistent xenobiotics. In recent years, attention has been given to anaerobic biodegradation of aromatic pollutants. The capacity of anaerobic microorganisms in Lake Ontario sediments was therefore considered to be of importance. Cross-adaptation to polysubstituted chlorinated benzoates was thus investigated. Previously it had been shown that sediments along the Toronto waterfront had elevated levels of aromatic pollutants. In the present work, sediments from six sites in this area were anaerobically suspended in Revised Anaerobic Mineral Medium (RAMM) for incubation with halogenated benzoates. Following adaptation, to monohalogenated benzoates (3-bromobenzoate, 3-chlorobenzoate), cross-adaptation to complex halogenated aromatics (3,5-dichlorobenzoate, 4-amino-3,5-dichlorobenzoate) was assessed by monitoring their depletion with high pressure liquid chromatography. Cross-adaptation to the two complex aromatics showed that prior adaptation to 3-bromobenzoate resulted in a more rapid depletion of both complex substrates than prior adaptation to 3-chlorobenzoate. The results appear to confirm the pathways which have been established with regard to anaerobic biodegradation of benzoates. The feasibility of inducing biological breakdown of complex halogenated aromatics suggests possible practical application. The next step should be to cultivate the biodegradative microorganisms as a consortium in order to allow for their controlled use either in <u>in situ</u> or in waste water treatment facilities.

SESSION B

WATER QUALITY RESEARCH

Poster Presentations

BP1

THE EFFECTS OF AGRICULTURAL DRAINAGE ON SEDIMENT AND WATER QUALITY LOADINGS. **W. E. Watt, Civil Engineering Department Queen's University, Kingston, Ontario K7L 3N6.**

The project, presently 1 year into its 3 year schedule, commenced with a literature survey on the pathways and fates of agricultural chemicals (fertilizers and pesticides). A field program has been implemented to instrument both a tile-drained field and a small agricultural basin. Volumes and rates of runoff are being monitored on a continuous basis. Concentrations and loadings of nutrients and pesticides (atrazene) are determined under significant runoff events through the use of a flow-activated water quality sampler. A continuous, physically based hydrologic simulation model for tile-drained agricultural fields and basins, developed under a previous M.O.E. funded research project, is being used to assess simple algorithms to represent processes for chemical transport through the soil profile and into the tile drains. The effects of factors such as soil porosity, soil type and depth, surface runoff, and timings and volumes of precipitation over the growing season on the transport processes are demonstrated graphically in terms of loading and concentration of the water quality parameters. Published Canadian data on nutrients and pesticides for tile-drained fields have been used for preliminary testing of the submodels. Future work will involve the finalization of algorithms for water quality transport models as sampling data becomes available. The calibrated model for nutrient and pesticide transport will be used in the assessment of the potential effectiveness of various agricultural management practices in reducing the loss of nutrients from fields or in abating the delivery of pesticides into receiving streams.

BP2

WatQUAS 2.0: AN EXPERT SYSTEM FOR THE WATER QUALITY ASSESSMENT OF ONTARIO RIVERS. Wm. C. Allison, T.E. Unny, and L. Logan, Department of Civil Engineering, University of Waterloo, Waterloo, Ontario, N2L 3G1.

The analysis of water quality sampling data for a site is a complex task and it is often difficult to interpret the results. WatQUAS 2.0 is a water quality assessment tool that initially conducts a thorough numerical evaluation of historical water quality records. The results of the numerical analysis are then subjected to an expert interpretation. Large qualities of heuristics and domain and expert knowledge are utilized by the expert system in order that inferential conclusions and recommendations regarding the water quality may be achieved. WatQUAS 2.0 possesses a large knowledge base which contains detailed information pertaining to many conventional, organic, and bacteriological pollutants. The MOE EMPPL was used as a basis for determining which contaminants presented a danger in Ontario. The chemical hazard rating system developed for the EMPPL is utilized by WatQUAS 2.0 to determine specific contaminant hazards. A Data Base Management System is utilized to organize the knowledge block and to permit ease of access to its contents by the users. The knowledge base and heuristics have been expanded and reorganized in this second version of the Expert System. WatQUAS 2.0 will be available for operation on an IBM PC and is capable of assessing a wide range of water quality situations. Further expansion of the knowledge base, heuristics and scope of the WatQUAS Expert System is still required. Extensive testing and evaluation in conjunction with Environment Ontario personnel will uncover problems and weaknesses in the second version.

BP3

GEOCHEMICAL CHARACTERIZATION, SIZE FRACTIONATION AND BIOAVAILABILITY OF TRACE METAL PARTICULATE ASSOCIATIONS IN THE DON RIVER. Lesley Warren* and A.P. Zimmerman, Department of Zoology, University of Toronto, Toronto, Ontario M5S 1A1.

The total concentration of trace metals found in the receiving waters of the Metropolitan Toronto Area are indicative of a serious contamination problem. It has become increasingly evident that assessment of the environmental impact of metal loadings depends more on knowledge of metal speciation rather than total concentration. Significant fractions of trace metals end up bound to suspended particles with their ultimate fate (burial, resuspension, bioaccumulation *etc.*) connected to the fate of the system's particulate fraction. OMOE has articulated a need to determine the physical and chemical characteristics of suspended particulates in order to assess accurately the impact of metals on aquatic ecosystems. We are in the process of evaluating **A)**. the magnitude of metal transport by suspended sediments in the Don River; **B)**. the geochemical associations of metals with suspended sediments; **C)**. the relationships between particle size, metal load, and geochemical phase; and **D)**. if particle size or geochemical phase have any predictive power for filterfeeding benthic body burdens of metals. Four sites along the Don, progressing from the headwaters to the Bloor Street Viaduct are under investigation. Suspended sediments from these sites were concentrated using continuous flow centrifugation and geochemically characterized using sequential extraction. Periodically at one site, suspended material was size fractionated and geochemical associations were analyzed within particle size classes. The associations of copper, cadmium, zinc and lead with specific geochemical classes were determined using flame atomic absorption. Body burdens of in-situ filter-feeding benthos were analyzed for the same 4 metals. Early results indicate metal levels in suspended material exceed provincial guidelines for dredgeate material (ranges across the 4 sites in ug/g: cadmium 1.9 - 74; copper 18 - 480; zinc 420 - 7000; lead 60 - 2700). Of the 4 metals, cadmium shows the most predictable pattern of binding; it was only associated with the easily exchangeable and iron, manganese oxide fractions. Copper and lead show the most variable patterns of geochemical association with highest levels of copper appearing either in the organic, residual or oxides fractions; while lead levels were highest in the residual or oxides fractions.

BP4

THE INVESTIGATION, EVALUATION, AND RECOMMENDATIONS OF BIOMONITORING ORGANISMS FOR PROCEDURES DEVELOPMENT FOR ENVIRONMENTAL MONITORING. C.A. Jefferson, Curry Jefferson Environmental Services, R.R.#4 Port Perry, Ontario L0B 1N0.

The problem addressed by this project was the availability of a single, or group of biomonitoring organisms, which can be used in routine contaminant monitoring programs. Programs, requiring discharge monitoring of contaminant levels in biological organisms to determine impact trends with time and space and pinpoint contaminant sources, are expanding. These programs require a common basis for comparison. Consequently organisms proven to provide reliable, consistent and scientifically defensible data, and which are inexpensive tools, must be developed and utilized. The specific objectives of the project were to; determine if one species of organism was most appropriate for biomonitoring, particularly with respect to a specific dishcarge type; to recommend one species of organism or a combination for either a specific situation, or group of contaminants; to suggest further research needs. The project involved discussions with researchers; a comprehensive and extensive review of the literature from international provincial and federal governments, industry, and educational institutions. The bulk of the literature pertains to the marine environment with particular respect to molluscs. The freshwater data emphasizes the mollusc but with the exception of work undertaken by the Ontario Ministry of the Environment, no solid database of one particular species or particular contaminant has been developed. Literature on the use of algae, benthic organisms other than bivalves, zooplankton, macrophytes, and fish is not widely available. The Ontario Ministry of the Environment has the best database of fish/contaminant use. The project findings suggest that; clams be retained and leeches further developed as biomonitoring organisms for relatively short-term studies (1 week to 4 months); clams be utilized for certain metals,dioxins, furans, and organochlorine contaminants, while leeches be developed for chlorophenols; procedures be developed for the use of these two roganisms; and the small yearling yellow perch/spottail shiners continue to be used as long-term (4 months to 1 1/2 years) biomonitors of wider geographic scope. Clams and leeches can be used singly or in tandem to pinpoint and define the nature and source of the specific contaminant problem.

BP5

THE ONTARIO INLAND LAKES PROGRAM AND MANAGEMENT OF BLUE-GREEN ALGAE: THREE WHOLE LAKE TREATMENTS IN 1988. H. Vandermeulen * and K.H. Nicholls, Ministry of the Environment, Water Resources Branch, Box 213, Rexdale, Ontario M9W 5L1

While Ontario's phosphorus control program has achieved measurable reductions in blue-green algal blooms in some inland lakes, there exist many other surface waters for which conventional nutrient loading controls are not practical. One of the objectives of the inland lakes program is to apply other methods to control excessive growths of blue-green algae in eutrophic lakes and reservoirs in Ontario. We are using the "whole lake" approach to accomplish this task. Three different projects were initiated during the summer of 1988, destratification using a Garton style propeller with an upwelling tube at Guelph Lake, hypolimnetic aeration at a small kettle lake in London and a calcium carbonate addition to Puslinch Lake. The methods employed are relatively straightforward in theory while the logistics of treatment can be quite involved. Coordination of suppliers and contractors, along with the need to satisfy legal and permit requirements, can lead to long periods of delay due to unexpected problems. Experiments on this scale require time schedules of years rather than months to obtain reliable results. The information and experience obtained from these three projects will be applied to other whole lake treatments in 1989. We hope to be able to test a variety of methods for blue-green algal control and ultimately be in a position to recommend the best treatment for a given lake-bloom situation.

BP6

CHARACTERIZATION OF THE GRAZING FAUNA WITHIN FIVE SOFTWATER LAKES WITH RESPECT TO ACCUMULATIONS OF METAPHYTIC FILAMENTOUS ALGAE. P.M. Stokes*, E.T. Howell and R.L. France, Institute for Environmental Studies, University of Toronto, Toronto, Ontario M5S 1A4.

The zoobenthic communities within the littoral zones of five Haliburton-Muskoka lakes were examined during summer 1987. Three of these lakes experience late summer growths of Zygnematacean algal clouds or metaphyton. Previous research has hypothesized that diminished grazing pressure through extripation of acid sensitive herbivores may allow for the proliferation of such metaphyton under low pH conditions. Our present work found that no overt differences existed among the abundances of micro- (cladocerons, oligochaetes, chironomids etc.) or meio- (amphipods, gastropods, emphemeropterons etc.) - grazers in lakes with or without metaphyton. Notable differences did exist, however, with respect to what we term macro-grazers. Crayfish, tadpoles and oligovorous cyprinids were absent or rare in the three lakes with extensive metaphytic algae but abundant in those without. If alterations in grazing pressure can be implicated as an important attribute underlying metaphyton development, our correlative results suggest that it is these large grazers (particularly crayfish) that will be the most likely candidates. A considerable grazing- literature exists providing inferential support for this hypothesis.

BP7

SEDIMENTARY CHRYSOPHYCEAN CYST ASSEMBLAGES AS PALEOINDICATORS IN ACID SENSITIVE LAKES. Rybak, M., Rybak, I., Nicholls, K., ARECO CANADA INC., 800-180 Elgin, Ottawa K2P 2K3

Relationships between surface sediment cyst assemblages and lakewater characteristics were studied in 50 lakes located in central Ontario. The main purposes of the study were to identify the environmental factors most strongly controlling the distribution of chrysophycean cysts and to develop indices and equations to infer lake water pH from cyst assemblages. Principal components analysis indicates that alkalinity and associated TDS as well as elements related to trophic status are the most important factors controlling the distribution of chrysophycean cysts. There are significant differences in the relative importance of these factors among the lakes. The transfer functions developed provide good prediction of pH values. The study also provides a descriptive analysis of the "fossil" chrysophycean cyst flora of Ontario lakes. The descriptions include representative SEM micrographs and detailed characterization of each morphotype in consideration of the morphological variation observed among specimens of the same morphotype. Special attention has been paid to the anatomy of the collar complex and to the nature of the cyst surface ornamentation. One hundred thirty seven morphotypes are described, most of them for the first time.

BP8

FACTORS REGULATING CONTAMINANT LEVELS IN FORAGE FISH SPECIES. C.E. Hebert* and G.D. Haffner, Great Lakes Institute, University of Windsor, Windsor, Ontario, Canada. N9B 3P4.

Environment Ontario currently uses a forage fish species, the Spottail Shiner (Notropis hudsonius),to monitor the spatial distribution of contaminants in the Great Lakes as well as to evaluate long-term trends in contaminant levels. However, little is known of the factors that regulate contaminant accumulation in this species or in forage fish in general. In this study the relative importance of physiological, chemical, and ecological factors in determining contaminant burdens in forage fish species was examined. Three species of forage fish: N. hudsonius (Spottail Shiner), Pimephales notatus (Bluntnose Minnow), and Labidesthes sicculus (Brook Silverside) were collected monthly, during 1987, from the St. Clair River system to evaluate the spatial and temporal variability in levels of pentachlorobenzene,hexachlorobenzene,and octachlorostyrene. Contaminant levels in these fish species reflected the spatial heterogeneity of exposure along the St. Clair River system. Significant interspecitic differences in contaminant burdens were observed. Microhabitat utilization was found to be important in regulating body burdens in these species. Highest contaminant levels were observed in P. notatus a specialized benthic feeder and the lowest accumulations were seen in L. sicculus an obligate surface feeder.

BP9

THE ISOTOPIC COMPOSITION OF UPLAND FOREST SOIL SULPHATE.
D.R. Van Stempvoort* and P. Fritz. Dept. of Earth Science, University of Waterloo, Waterloo, Ontario, N2L 3G1.

The environmental impact of anthropogenic sulphur is both a regional and global concern. The nature of this impact depends in large part on the chemical responses of forest canopies and soils to sulphur deposition from the atmosphere. There is a complex array of processes that can affect dissolved (and gaseous) sulphur compounds as they pass through the canopies and the soils. An example of the processes would be biological redox cycling by plant and soil microbes. Oxygen and sulphur isotopic analyses on the various components of the forest sulphur cycle can determine relative importance and/or occurence of these processes. Our study area is a small subcatchment of the Plastic Lake watershed located near Dorset, Ontario. Upland soil water sulphate in this watershed has a distinct oxygen isotopic content (range $\delta^{18}O$=4.34-6.35 $^{o}/_{oo}$) relative to local precipitation sulphate (avg. δ^{18} =11.35 $^{o}/_{oo}$). This must be due to chemical or biological reactions in the soil or above ground forest vegetation. Throughfall and stemflow samples indicate that, at most, a very small shift (<1 $^{o}/_{oo}$ drop relative to rain) takes place in vegetation during spring and summer. SO_2 absorption by soil, snow or vegetation may be an important process, but preliminary data indicate no significant isotopic shift. Sulphate adsorption by hydrated Fe and Al hydroxides does not have a significant isotopic fractionation. Soil microbial mineralization of organic sulphur produces secondary sulphate and this process is apparently the major cause of the oxygen isotope shift between precipitation and upland soil sulphate. The isotopic composition of sulphur in vegetation, soil organic matter and soil moisture (avg. $\delta^{18}O$ ranges from 3.65 to 5.72) is similar to the precipittion sulphate value (3.84 $^{o}/_{oo}$).

BP10

RECENT TRENDS AND HISTORICAL CHANGES IN WATER QUALITY OF LAKE MUSKOKA. Rybak, M., Rybak, I., Nicholls, K., ARECO CANADA INC., 800-180 Elgin, Ottawa K2P 2K3

The primary objective of the study is to analyse and document long-term changes in the development of lake ecosystem in relation to anthropogenic impact. In the study, priority is given to document historical changes and spatial variation of heavy metal contamination, especially the problem of elevated mercury levels. The research provides also evidence of long-term changes of water quality in Gravenhurst Bay with special emphasis on the trophic conditions before and after the phospohorus removal operation initiated in 1971. Documented changes in water quality are interpreted against the past and present shorline development as well as the disturbance history of lake watershed.

BP11

IN-SITU DETERMINATION OF FECAL INDICATOR BACTERIAL SURVIVAL IN AGRICULTURALLY-IMPACTED WATERSHEDS; M.J. Walters, Lake Simcoe Region Conservation Authority, Newmarket, Ontario.

In September, 1987, the Lake Simcoe and Metropolitan Toronto and Regional Conservation Authorities began research on the survival characteristics of fecal indicator bacteria in rural watersheds. Sampling locations included: 3 sites in Pefferlaw Creek (LSRCA); 1 site in the East Humber River; and 2 sites in Centreville Creek (MTRCA). The bacterial parameters studied during the first year of this 2 1/2 year project included: pure cultures of Escherichia coli and Pseudomonas aeruginosa, and fecal coliforms and Pseudomonas aeruginosa in mixed cultures containing total heterotrophic bacteria.

The water column survival of these bacteria and sediment survival runs of E. coli have been completed at each of the 6 sites under all seasonal conditions, making a total of 100 runs to date. Water column temperature and chemical parameters were monitored to determine their effect on bacterial survival. Bed sediment nutrient levels and particle sizes were also analyzed.

Water column bacterial die-off rates in the 3 watersheds ranged from 0.1 to 0.35 Log Units/Day for E. Coli; 0.02 to 0.4 Log Units/Day for fecal coliforms; 0.03-0.28 Log Units/day for P. aeruginosa; and 0.01 to 0.25 Log Units/day for P. aeruginosa (Mixed culture).

Some seasonal effect on the E. coli and fecal coliform rates was observed with more rapid die-off occurring during the summer and spring. Rates for P. aeruginosa and P. aeruginosa (mixed culture) tended to be slower during warmer weather in Pefferlaw Creek however, this trend was not as evident in the 2 MTRCA watersheds. E. coli die-off in bed sediments was less rapid than in the water column (0.01 to 0.1 Log Units/day). Somewhat faster rates were noted during the winter and spring.

Statistical comparisons of the die-off rates between sites were performed by regression analysis. The analyses show that bacterial survival in both the water column and bed sediments can vary within a watershed, and is thus site specific. The insitu relationship between water temperature, nutrient concentration and bacterial survival has not been established. It would appear though, that within the EC/FC group, survival is enhanced when both water temperature and nutrient levels are in positive correlation.

BP12

DEVELOPMENT OF AN ACUTE AND CHRONIC SEDIMENT BIOASSAY PROTOCOL USING LARVAL MAYFLIES AND JUVENILE FATHEAD MINNOWS. G. Krantzberg[1] and R. Pope[2], Water Resources Branch, Ontario Ministry of Environment, 1 St. Clair Ave. W., Toronto, Ontario. [2]Tarandus Associates Limited, 21 Greystone Crescent, Brampton, Ontario L6Y 2B2.

ABSTRACT

The principal objective of this series of laboratory investigations was to develop a methodology for assessing acute and chronic impacts of contaminated sediments to the biota and to assess the bioavailability of contaminants by measuring tissue retention of some polar and non-polar compounds. The effects of sediment manipulation during bioassay assembly were investigated. The importance of the equilibration period, prior to the introduction of test organisms, was examined to determine whether growth, bioaccumulation, or mortality were sensitive to this variable. For both test species, chronic and acute endpoints revealed that toxicity was significantly reduced by extending the period of equilibration from 5 hours to 5 days.

Further studies on sediment manipulation compared the toxicity of intact, diver-collected cores to bulk samples that were sieved and homogenized. For sandy sediments, homogenization enhanced toxicity. This was considered to be a result of physical loss of suitable substrate for colonization or foraging. For fine-grained organic sediments, homogenization altered toxicity, but was substrate-dependent. We also investigated whether bioassay endpoints were density dependent. For 2L microcosm containing a 3 cm depth of sediment (surface area = 100 cm^2) and 1.6 L of water, chronic endpoints were density dependent when more than 10 mayfly nymphs (c.a. 25 mg/individual, wet weight) or more than 10 fathead minnows (c.a. 0.5 gms/individual, wet weight) were employed. Additional research on broader range of organisms is recommended to further develop the use of chronic bioassays (e.g., full or partial life cycle tests) in assessing sediment quality.

BP13

THREE HOUR PULSE EXPOSURE OF THIOCYANATE (SCN^-) TO RAINBOW TROUT EGGS BEFORE AND AFTER WATER HARDENING. Sherrene D. Kevan* and D.G. Dixon, Department of Biology, University of Waterloo, Waterloo, Ontario, N2G 3L2.

Thiocyanate (SCN^-) is an oxidation product which is found in mining wastes where cyanide has been used in the flotation process of mineral ores. Although mining effluent is released continuously, pulse exposure of SCN^- to fish could result from spring runoff, accidental spills, and mixing zone areas. The toxicity of SCN^- to rainbow trout eggs was examined. Eggs were dry fertilized and exposed for 3 hours to KSCN concentrations ranging from 90 - 2880 mg/l. Another batch of eggs was fertilized, allowed to water harden for 3 hours, and then exposed to the same concentrations listed above. Mortality was monitored weekly. At hatch, deformities and mortalities were recorded. Results show that percent survival to hatch was lowest at 2880 mg/l (21%) before water hardening. Deformities were highest at 1440 mg/l (8%) and 2880 mg/l (9.6%) before water hardening. Estimated 3h PE50 values for rainbow trout eggs before and after water hardening are 2019 and 1530 mg/l respectivly. Further investigations on the effects of SCN^- pulse exposures to early life stages of rainbow trout are currently underway.

SESSION C

LIQUID AND SOLID WASTE RESEARCH
Oral Presentations

LIQUID AND SOLID WASTE RESEARCH

Ulo Sibul
Waste Management Branch
Environment Ontario

Research needs in the handling, treatment and disposal of liquid and solid wastes not conveyed to municipal sewage treatment plants are necessarily as diverse as the materials that make up the waste streams.

Future research needs identified by the Ministry of the Environment fall into one or more of three broad categories:

Waste Handling
Waste Reduction
Landfill Technology

A total of fifteen general issues have been identified within these categories.

It is important that waste materials have all pertinent characteristics determined so that the need for treatment, the appropriate method of treatment and the required degree of treatment can be accurately identified.

Having identified a need for some type and degree of treatment, it has become necessary to develop and demonstrate the appropriate treatment methodologies.

The best case situation occurs when there is no waste to treat. This is an unrealistic goal but there is a recognized need to investigate, develop and demonstrate the so-called "4 R's" of waste management, the reduction, recycling, recovery and re-use of waste materials.

Landfill sites will continue to be the ultimate repository of residual wastes, treated or untreated, and it is a requirement to investigate, improve and enhance landfill technology to ensure safe and aesthetically acceptable disposal of the wastes that inevitably will occur. This has been a fruitful field of study in the past but will continue to deserve attention as our understanding of waste materials and behaviour expands. The control of contaminant migration from landfill sites and the safe containment of potentially dangerous wastes, including bio-medical wastes and incinerator ash requires study as does site rehabilitation and remediation for existing sites.

The ever increasing volumes of wastes makes this a challenging and rewarding subject for research.

C1

AN OVERVIEW OF HYDROGEOLOGICAL ASPECTS OF WASTE DISPOSAL: RESEARCH RESULTS AND IMPLICATIONS; J. Cherry, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario.

SEE LIQUID AND SOLID WASTE RESEARCH SESSION C PROCEEDINGS BOOK FOR THE EXTENDED ABSTRACT.

C2

IMMISCIBLE LIQUIDS AND VAPOURS IN SOIL: RECENT EXPERIMENTS ON TRANSPORT AND CONTROL. G. Farquhar*, R. Bensen, D. Graham, E. McBean and B. Stickney, Civil Engineering, University of Waterloo, Waterloo, Ontario N2L 3G1.

This paper provides a summary on some recent results from an on-going research programme studying the transport and control of hazardous immiscible liquids and their vapours in soil environments. Results are presented on the transport of pentane vapours from two different liquid source configurations within a long, thin chamber containing dry sand. The results were then successfully simulated using a two-dimensional mathematical mass transport model and these simulations are shown graphically. The paper also provides preliminary results from laboratory scale experiments examining air stripping as a means of removing volatile solvents from soil. One such experiment involves an air purge of 50 cm of sand with the lower quarter of the column containing hexane at residual saturation. The results show an increase in hexane content of the exhaust gas to near ambient vapour pressure and then a decrease as the liquid in the soil reaches depletion. A mass balance showed a nearly complete recovery of the hexane. Subsequent experiments have studied the impact of air flow rate, source geometry and air flow configuration on recovery efficiency. Experimental work has continued the study of immiscible liquid movement in porous media. The paper reports on current work to improve measurements of capillary pressure in soils with water and immiscible liquid mixtures especially in the bubbling pressure region.

C3

EFFECTS OF INCREASING AMOUNTS OF NON-POLAR ORGANIC LIQUIDS IN DOMESTIC WASTE LEACHATE ON THE HYDRAULIC CONDUCTIVITY OF CLAY LINERS IN SOUTHERN ONTARIO. F. Fernandez* and R.M. Quigley, Geotechnical Research Centre, Faculty of Engineering Science, The University of Western Ontario, London, Ontario, N6A 5B9.

The results of a three-year research study of the effects of organic liquids on the integrity of southern Ontario clayey soils used as barriers below sanitary landfills are summarized. Concentrated organic solvents (> 70%) such as dioxane and ethanol produce spectacular (up to 1000-fold) increases in the hydraulic conductivity of clays at low effective stresses. Below 70% concentration, the viscosity of leachates containing dioxane or ethanol doubles or even triples that of normal leachate, resulting in significant decreases in **k**. At the higher concentrations, entry of the low dielectric constant organic liquids into the double layers causes their contraction and an increase in free pore space at constant void ratio that overwhelms any viscosity effects.

Results of tests run at vertical effective stresses of 0, 40, 80 and 160 kPa are presented to show that the presence of effective stresses on the samples during permeation greatly reduces, or even prevents, the increases in **k**. For all ethanol/leachate mixtures the application of σ'_v = 40 kPa prevented any increase in **k**. For high concentrations of dioxane in leachate, however, much higher stresses are required. Effective stress application subsequent to the large increases in **k** produced by the concentrated dioxane permeation at σ'_v = 0 failed to improve the soil. It appears the stresses must be in place on the water-compacted clay in order to effect chemical consolidation during dioxane permeation.

C4

TECHNOLOGY REVIEW: BIOLOGICAL TREATMENT OF HAZARDOUS LANDFILL LEACHATES. J. FEIN* AND P. YU. DIVERSIFIED RESEARCH LABORATORIES LTD., TORONTO, ONTARIO M4W 2L2.

The current status of bioremediation technology for the detoxification and degradation of industrial pollutants in hazardous landfill leachates and groundwaters was assessed, based on a review of the current literature, discussions with experts in the field and site visits to several biological treatment facilities. The report considers the relative advantages and disadvantages of this important emerging new technology compared with that of existing non-biological remediation methods. The report also includes a microbiological and chemical risk assessment of biological treatment. Case studies are presented illustrating the diversity of biological treatment processes that are now in actual practice or under development. It is concluded that this new technology has considerable applicability for Ontario landfill leachate management. It is our recommendation that industry and government bodies in Ontario encourage and support further research and development work in this field.

C5

PHASE PARTITIONING KINETICS AT INDUSTRIAL WASTE LAND TREATMENT SITES

by D. Hockley and W.J. Snodgrass

The overall goal of this project is to develop an understanding of the behaviour of organic chemicals in land treatment systems under steady and non-steady conditions. This understanding will aid development and evaluation of protocols for land treatment systems and decommissioning schemes.

In this study, the interphase kinetics of three organic chemicals, such as phenol and toluene, have been measured using C-14 tracer techniques. Kinetics have been assessed between air, water, soil and oily phases in laboratory scale systems. Both batch and column tests have been performed. Model development work has been based mainly upon column data. Three soils have been assessed similar to a Nanticoke clay and lakeshore sand.

The results are being developed into a format for evaluating under what combinations of conditions (adsorption characteristics, moisture content, infiltration rate) equilibrium and non-equilibrium concepts are appropriate for modelling downward movement of these organics in the unsaturated zone of soils.

C6

PRELIMINARY ASSESSMENT OF A MICRO-FILTRATION / REVERSE OSMOSIS PROCESS FOR THE TREATMENT OF LANDFILL LEACHATE. Thomas A. Krug and Sandra McDougall, ZENON Environmental Inc., Burlington, Ontario, Canada

Landfill leachate may contain a variety of toxic inorganic and organic contaminants that are difficult to treat by conventional processes. A potential two stage precipitation/microfiltration (MF) and reverse osmose (RO) process has been evaluated for its suitability in the treatment of landfill leachate. Experiments demonstrated that the precipitation/microfiltration process can be used to remove suspended solids, metals and hardness from raw leachate water generating a product stream suitable for further treatment by reverse osmosis. Membrane flux varied greatly with the precipitation methods used but a stable flux of 25 $m^3/m^2/d$ was obtained at recoveries of up to 80%. Reverse osmosis experiments demonstrated the capability of RO in removing residual organics and dissolved solids. Total organic carbon (TOC) and conductivity of 500 mg/l and 7.6 micromhos in the feed to the RO were reduced to 30 mg/l and 0.2 micromhos in the RO permeate. Stable flux rates in excess of 0.65-0.73 $m^3/m^2/d$ were obtained at recoveries up to 50% with leachate treated by microfiltration. The processes evaluated can also be useful in the treatment of a variety of complex industrial waste streams.

C7

ANAEROBIC TREATMENT OF LANDFILL LEACHATE

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Leachate generation at landfill sites continues to be a serious environmental problem. It is, therefore, necessary to address this with a suitable treatment scheme. The enhanced sanitary landfill (ESL) was developed at ORF to provide leachate treatment and, at the same time, relatively fast land reclamation.

A pilot scale anaerobic digester was constructed and operated over a one-year period at the Region of Peel's Britannia Road Landfill Site in Mississauga to investigate the treatability of landfill leachate. In this paper, the results of the programme are presented and discussed.

C8

THE ORIGIN AND DISTRIBUTION OF METHANE IN THE ALLISTON SAND AQUIFER. R. Aravena*, J. Barker, M. Bliss and L. Wassenaar, Institute for Groundwater Research, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, N2L 3G1.

Methane is one of the major groundwater contaminants in some parts of the Alliston aquifer complex. This aquifer is the major water supply for towns such as Alliston, Cookstown and Bond Head and is an essential water resource for a growing population. The distribution and origin of the methane in this aquifer system is not well established. Two hypothesis exist. One suggest that methane is bedrock controlled. This means that the source is leakage from the underlying bedrock. However, isotopic evidence suggest that the methane is biogenic in origin and so the second hypothesis is that it is produced within the Alliston aquifer. An acceptable theory is required to predict areas that are likely to have water quality problems related with methane as this resource is developed. This could be extrapolated to other aquifers with a similar problem. A review of the existing hydrogeological information has been completed. This provides the framework for current geochemical and isotopic studies. An evaluation of the existing hydrogeological and geochemical data, including preliminary isotopic data related to the origin of the methane, will be presented in this conference. This presentation will be complemented with geochemical data gathered during the 1988 sampling season. A second phase of the study will be used to refine the geochemical interpretation and should produce an understanding of the origin of methane in the Alliston aquifer complex.

C9

THE CARBON AND SULFUR CYCLE IN SHALLOW UNCONFINED AQUIFER SYSTEMS. L.I. Wassenaar*, R. Aravena, R.W. Gillham, J. Barker and P. Fritz, Institute for Groundwater Research, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario, N2L 3G1.

Nitrate and sulfate are becoming increasingly common contaminants in shallow aquifer systems in Ontario due to agricultural practices and acid rain deposition. Natural remediation of these contaminants in some groundwaters by microbial denitrification and sulfate reduction requires labile organic carbon as an energy source. The objective of this study is to gain better insight into the role of natural organic carbon, both dissolved and solid, in the redox processes that occur in three shallow aquifers located near Rodney, Alliston, and Sturgeon Falls, by means of environmental isotopes and geochemical techniques. Preliminary data from Rodney and Alliston indicate an occurrence of high levels of nitrate and sulfate. The nitrate at Rodney and Alliston is derived from fertilizers. The sulfate at Alliston originates from acid rain, whereas, at Rodney sulfate is primarily from mineralized organic matter. Microbial redox processes occur at Rodney and Sturgeon Falls but not at Alliston. Our data suggest that the labile organic carbon pool for microbial redox processes at Rodney may be low molecular weight organic acids produced by fermenting bacteria. Additional data collected during the 1988 summer field season will also be presented. It is expected that synthesis and geochemical modelling of all data will aid in elucidating the role of organic carbon in the natural remediation of inorganic contaminants in these shallow groundwater systems.

C10

Determination of Organic and Inorganic Contaminants in the Welland River. Ian D. Brindle, Anne Wei Chu, and Xing-fang Li, Chemistry Department, Brock University, St. Catharines, Ontario L2S 3A1

Analysis of the organic contaminants in the Welland River will be presented. The Welland River has been involved in Ontario's industrial development since colonial times. A number of industries are sited along the Welland River, from the City of Welland to Niagara Falls. The variation in exogenous organic materials in the sediments will be revealed. Identification of unusual compounds in these sediments will also be discussed. Particular sources of inorganic contaminants will be discussed in terms of possible remedial action plans.

C11

RESEARCH AND DEVELOPMENT OF PERMANENT ONSITE SOLUTIONS FOR CONTAMINATION OF GROUNDWATER AT WASTE DISPOSAL AND INDUSTRIAL SITES IN CANADA

Richard J. Rush
CANVIRO Consultants, A Division
of CH2M HILL Engineering Ltd.

This paper consists of an overview of a recently-awarded two-year project to research, develop and demonstrate permanent onsite solutions for groundwater contamination, specifically contamination attributable to toxic organic chemicals. The Uniroyal Chemical Manufacturing Plant in Elmira, Ontario has been selected as a demonstration site for the methods developed. The project is being conducted in conjunction with Morrison-Beatty Limited, and it is being funded by the Department of Supply and Services, the Ontario Ministry of the Environment and Uniroyal.

Phase I of the project will include a technology update (ie. literature review) on groundwater treatment methods, screening of treatment technologies, laboratory and pilot scale studies on groundwater and soil samples from the Uniroyal site, the development of a hydrogeological management model for assessing recovery and injection well networks, and preliminary design work for the selected technologies.

Phase II of the project will consist of field scale demonstrations of selected technologies. In situ purge well testing followed by treatment of groundwater at surface (ie. air stripping with off-gas treatment, granular activated carbon) have been identified for possible implementation. A comprehensive evaluation will be made for each of the demonstrations performed, and where possible, recommendations will be made regarding the applications of these technologies at other industrial and waste disposal sites with groundwater contaminated with organic chemicals.

C12

THE ROLE OF GROUNDWATER IN HUMAN SOCIETY; R.N. Farvolden, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario.

SEE LIQUID AND SOLID WASTE SESSION C PROCEEDINGS BOOK FOR THE EXTENDED ABSTRACT.

C13

DISPERSION OF THE STOUFFVILLE LANDFILL PLUME.

I. Proulx* and R. N. Farvolden, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario N2L 3G1

The contaminant plume in the Oak Ridges aquifer from the Stouffville landfill now extends some 750m off-site to the southwest, in the direction of groundwater flow. The plume is defined by the 20 mg/l Cl^- isochlor and zones which in 1984 were up to 122 mg/l are coincident with the highest levels for other parameters. The migration rate is about 20-40 m/year and longitudinal dispersion is 15-40m. Lateral dispersion is small. The arrival times of contaminants at observation wells and their distribution in the plume are the basis for interpretation of the routes and the rates of flow in the system. Liquid wastes leaked rapidly from the disposal "lagoons" (kettle in the Halton Till) and reached the underlying Oak Ridges aquifer within about one year. The temporary groundwater mounds created in the aquifer by this eposodic recharge caused some lateral spreading of the contaminants. Our model shows little groundwater recharge through the Halton Till except at the "lagoon" sites. Throughflow of groundwater from recharge zones upgradient carries the plume downgradient, and causes some dilution. The cores of the main Cl^- plume and the smaller plumes of other parameters are all weakening with time and also weaken in the upgradient direction. This indicates that the source has weakened or ceased, and is further evidence that the plumes derive mainly from the disposal of liquid wastes in the lagoons. A transport model indicates that the contaminant levels in the plumes will decay to near background concentrations in about ten years, that is, by about the year 1998. We conclude that leachate from decomposition of the solid wastes in the landfill has not yet reached the Oak Ridges aquifer.

C14

COMPARISON OF AN EXPERIMENTAL MUNICIPAL REFUSE COLUMN STUDY WITH LANDFILL FIELD TEST CELLS.

S. Pirani and D.W. Kirk, Department of Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Ontario, M5S 1A4.

Results from municipal refuse column test cells (0.143 m^3) are compared with Boone County, Sonoma and Center Hill US EPA studies which used "small" and large field test cells ranging from 6.73 m^3 to 677 m^3. Data from the column studies are reported for a 3.5 year period. These column studies were operated under unsaturated flow conditions with both controlled and atmospheric moisture input.

The normalized, weighted-mean leachate concentration data from the column studies were compared with the field studies. The bulk leachate parameters such as COD and pH had the same magnitude, variability and time function as did the reported field test data for the small cells. Data for the large field test cells typically showed slightly lower values. Other parameters such as specific metal ion concentrations showed the same trends but not necessarily the same magnitudes. Simple first order exponential models adequately describe leachate behaviour. The applicability of column studies is evaluated.

C15

THE ALTERNATIVE TO INCINERATION OF BIOMEDICAL WASTE

HAMMERMILL/CHEMICAL DECONTAMINATION

by

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ABSTRACT

Both the Ministries of Health and the Environment have provided funding to the Hospital Council of Metro Toronto (HCMT) to demonstrate the efficacy of the Indianapolis based, Medical Safe Tec Inc.'s biomedical waste manager. Approval has been given for HCMT to proceed with a six-month test program, using biomedical wastes provided by Toronto hospitals, under a rigorous protocol developed by an expert panel.

This paper describes the objectives of the project, the test protocol and the development of the environmental assessment that must be presented for approval of the Minister of the Environment at the end of the demonstration period before full scale operation is permitted.

C16

Erosion of Landfill Covers. J. Cuthill, Department of Land Resource Science, University of Guelph, Guelph, Ontario N1G 2W1. K. McKague, Ecologistics Limited, 50 Westmount Road North, Waterloo, Ontario N2L 2R5

A summary of this one year, three part study will be presented. Results from part one of this study which involved testing and calibrating a new lysimeter design will be presented as will be the perceived strengths and weaknesses of the prototype lysimeters. Modifications made during the study will be outlined and suggestions for improvements in the design are given.

Parts two and three of this study set out to determine if erosion of landfill covers is a problem in Ontario. A number of decommissioned landfill sites across the province were visited with the characteristics and erosion problem(s) at each site noted to determine the seriousness of erosion on landfill cover integrity. As well, a generalized conceptual model was developed to estimate the susceptibility of a landfill cover to erosion at any particular landfill site.

C17

DEVELOPMENT OF BACKFILL AND CONSTRUCTION APPLICATION GUIDELINES FOR ONTARIO. M. Kelleher* and B. Whiffin, CANVIRO Consultants, A Division of CH2M HILL ENGINEERING LTD., Mississauga, Ontario, L5N 1V9

Tentative guidelines were developed for the classification of industrial waste and by-product materials for backfill and construction applications. These tentative guidelines were based on results of bulk chemical characterization of the material in question, and also on leachate extraction procedure results. A tentative classification system was developed, based on the above two procedures. The effectiveness and reliability of these tentative guidelines are currently being tested through a field program which examines the impact of industrial materials used in backfill and construction applications. Three materials, are being investigated during this phase of the project, namely; blast furnace slag, fly ash and foundry sands. Sites which contain relatively large volumes of each of these materials were selected for a field study program. The program involves a hydrogeological investigation of each site, bulk chemical characterization of the material placed at the site, and a leachate extraction procedure carried out on the material placed at the site. Groundwater both upstream and downstream of the site is analyzed. The purpose of the field study is to assess the extent to which results of the bulk chemical characterization and leachate tests are an indication of the impact of material placement on downstream groundwater quality. The results of the field program will determine the effectiveness of the tentative guidelines, which will then be modified, as appropriate, based on the field program results.

C18

STEMMING THE RISING TIDE OF WASTE

Moderator: Don Mackay
University of Toronto

Members: Colin Isaacs
Pollution Probe Inc.

Romeo Palombella
Government Refuse Collection and
Disposal Association

Hardy Wong
Environment Ontario

The panel discussion will be recorded and transcribed. A printed copy can be obtained upon request from:

Ministry of the Environment
Research and Technology Branch
135 St. Clair Avenue West,
12th Floor
Toronto, Ontario
M4V 1P5
(416) 323-4574

SESSION C

LIQUID AND SOLID WASTE RESEARCH

Poster Presentations

CP1

RETRACTABLE COMPOSITE ADSORBENTS FOR ENVIRONMENT CLEAN-UP.

B.Gillies*, E.Stubley, I.Treurnicht and L.Read, EcoPlastics Ltd.,Willowdale, Ontario M2H 3B4
O. Meresz, Ministry of the Environment, Rexdale, Ontario M9W 5L1

ABSTRACT WITHHELD

CP2

TREATMENT AND DISPOSAL OF HAULED SEWAGE UNDER PART VII, ENVIRONMENTAL PROTECTION ACT. J.L. Smith, M.Sc., of Oliver, Mangione, McCalla & Associates Limited, 154 Colonnade Road South, Nepean, Ontario, K2E 7J5.

The purpose of this project is to undertake a survey and produce a report that describes current hauled sewage treatment and disposal practices, characterizes hauled sewage from a quantity and quality point of view, provides an overview of current problems respecting the treatment and disposal of hauled sewage and discusses options available for treatment and disposal in the future. Progress in 1987 included the establishment of a steering committee, the drafting of a data collection questionnaire, the submission of the questionnaire to each of the Health Units and Ministry of the Environment offices, the creation of a computerized database to catalogue and collate data and the collection of articles and information for the literature review. Progress in 1988 has included the compilation of summary statistices on hauled sewage practices, the completion of an extensive literature review and field visits to several sites including agricultural land spreading sites and lagoon and spray irrigation systems across Ontario. A preliminary report is being compiled outlining the current practices of treatment and disposal of hauled sewage under Part VII of the Environmental Protection Act. Future studies include an analysis of current practices and recommendations of alternative schemes for treatment and disposal in Ontario.

CP3

FACTORS AFFECTING THE CONCENTRATION OF METAL IONS IN MUNICIPAL REFUSE LEACHATE.

G. Kosta, S. Pirani and D.W. Kirk, Department of Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, Ontario, M5S 1A4.

The leachate generated from a municipal refuse landfill begins as precipitation and undergoes a number of changes as it percolates through the landfill environment. The initial air saturated water becomes increasingly anaerobic and becomes loaded with both inorganic and organic species before seeping into the water table. The impact of this liquid on the environmnent is determined by the volume discharged and the concentration of species in the liquid. Predicting the concentrations of metal ions in the leachate is very difficult due to the nature of the refuse and the reactions taking place in the landfill. Nevertheless the residence time of the liquid in the landfill could be sufficient to allow pseudo-equilibrium saturation to be established and thus allow maximum concentrations to be predicted through solubility laws. This work examines the concept of predicting metal concentrations in municipal refuse leachate and compares the results with experimental data.

CP4

SLOW RATE INFILTRATION LAND TREATMENT AND RECIRCULATION OF LANDFILL LEACHATE IN ONTARIO. R.A. McBride*, A.M. Gordon, P.H. Groenevelt, T.J. Gillespie and L.J. Evans, Departments of Land Resource Science and Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1

This paper presents a summary of findings from the second year of this three-year study. Three plot-scale installations (factorial, RCB experimental design) involving three irrigation methods (spray, trickle, sub-surface) and three leachate application rates (3.5, 7.0 and 14.0 $mm \cdot d^{-1}$) are operational at the Hamilton-Wentworth regional landfill in Glanbrook Township and at the Essex County landfill #2 near Leamington. The Glanbrook soils are comprised of about 55% clay (dominantly clay mica/vermiculite, unbuffered C.E.C. 52 $cmol \cdot kg^{-1}$, specific surface 250 $m^2 \cdot g^{-1}$) whereas the Leamington soils are contrastingly very coarse textured. Sub-plots vegetated with seedlings of various tree species have provided a basis for vegetative stress assessment with incremental leachate exposure. Changes in leaf transpiration and photosynthesis rates as well as a shift in "red edge" reflectance have been measured. Soil respiration rates and measures of microbial biomass by the ATP and chloroform-fumigation incubation methods are being used as indicators of soil toxicity. A "Constant Capacitance" model is being applied to metal adsorption isotherm data on both clay mineral and organic acid soil fractions. This should ultimately permit prediction of the fate of iron and other metals in leachates when applied to different soil types found in Ontario. Forty in-ground lysimeters have been installed to study the recirculation of MSW leachates through landfill cells with clay surface liners. The Glanbrook clay soil described above was used as the simulated liner with heavily contaminated sand material from the Muskoka Lakes landfill placed beneath the clay. Four vegetative covers and two leachate sources (Guelph, Muskoka Lakes) are included in the experimental design. The strength of leachates from all four sources is being indexed with LC_{50} toxicity tests using Daphnia magna.

CP5

ESTABLISHING VEGETATION ON EROSION-PRONE LANDFILL SLOPES IN ONTARIO, YEAR TWO, T.W.Hilditch* and C.P. Hughes, Gartner Lee Limited, Markham, Ontario L3R 8B6

Erosion may reduce the ability of a landfill cover to prevent precipitation infiltration and nuisance wildlife intrusion. Erosion may also impair site aesthetics and lead to costly yearly maintenance of vegetated areas. Vegetation failure on landfill slopes is most often associated with; low soil nutrient status, soil compaction, soil drying and the presence of decomposition gases in the rooting zone. This three-year research project was commissioned to address the landfill erosion problem by determining the best vegetation management methods for use in Ontario. Research began in 1987 with a computer-assisted, data-base search of available literature. A survey of current perceptions of landfill erosion and revegetation and the needs of Environment Ontario District enforcement staff was conducted by questionnaire. These initial contacts also served to identify 24 landfills representing a range of revegetation effort and success for subsequent field investigations. Of the 24 sites investigated in 1987, 8 were selected for test plots of the preferred technologies. Those 8 were located in the following Environment Ontario Districts: Kingston, London, Ottawa, Owen Sound, Peterborough, Sault Ste. Marie, Sudbury and York-Durham. Primary criteria for plant species selection included; shallow rooting form, drought and low nutrient tolerance and commercial availability. Six grass species and one legume meeting some or all of these criteria were tested on 3 to 5 plots per site. Planting variables included: aspect, degree of slope, slope length, soil type (sand or clay), depth and degree of tillage, soil amendments, material application methods and rates, and the use of mulch covers and erosion blankets. The test plot program results will assist in establishing trends in species growth and planting method success. The test plots will also provide information on the costs, advantages and pitfalls of various methods of site preparation and planting. An important end-product of this research will be a Landfill Revegetation Manual for Ontario, a data source for private landfill owners, municipal landfill operators and Environment Ontario District enforcement personnel. The third and final year of the project will see continued test plot monitoring to assess over-wintering survival, and the compilation of the Landfill Revegetation Manual.

CP6

EVALUATING GROUNDWATER VELOCITY IN A LOW-PERMEABILITY FRACTURED SHALE. K.S. Novakowski* and J.A. Cherry, Centre for Groundwater Research, Waterloo, Ontario N2L 3G1

Many recent hydrogeological investigations in fractured rock have shown that there is considerable uncertainty in the accuracy of predictions of groundwater velocity in discrete fracture planes. Since many landfills and industrial sites in Southern Ontario are underlain by low-permeability shale bedrock pervaded by high-permeability fractures, a site was selected in the Meaford-Dundas shale with the intent to study velocity in one of the high-permeability features. A total of 7 boreholes were drilled in a 30 x 30 m area intersecting a single flat-lying fracture at a depth of about 10 m. Approximately 80 constant-head hydraulic tests were conducted to define the intersection of the fracture in each borehole. In addition, slug tests, pulse interference tests, pumping tests and injection-withdrawal and radial-convergent tracer tests were conducted in and between the boreholes to determine the average fracture aperture width and the lateral continuity of the fracture plane.

The hydraulic test results show that the fracture plane is characterized by a relatively uniform aperture width of about 220 μm, but is continuous in only 4 of the 7 boreholes (present but closed in the others). The tracer test results suggest that the groundwater velocity predicted using the hydraulic test results may overestimate actual groundwater velocity by up to a factor of 4. The discrepancy in predictions is believed to be the result of unaccounted for tortuous flow pathways which influence the results of tracer experiments but not hydraulic tests.

CP7

THE DESIGN AND EVALUATION OF "IN-SITU" BIORESTORATION METHODS FOR THE TREATMENT OF SLUDGES AND SOILS AT WASTE DISPOSAL SITES. K.L. Berry-Spark* and J.F. Barker, Institute for Groundwater Research, University of Waterloo, Waterloo, Ont., N2L 3G1.

In situ methods for treatment of waste sludges hold great promise for the cost-effective, efficient remediation of sludge at disposal sites. Laboratory experiments using sludges and soils from the MacDougall waste disposal site near Brockville, Ontario were conducted to evaluate in situ bioremediation techniques. Several samples of soil and sludge were found to contain significant concentrations of petroleum hydrocarbons and chlorinated hydrocarbons. Biodegradation experiments were designed to specifically evaluate these constituents. The samples underwent microbial testing which confirmed the existence of viable aerobic, anaerobic and sulphate-reducing bacteria. The biodegradation of aromatics and chlorinated hydrocarbons was evaluated under aerobic, methane-oxidizing, sulphate-reducing, denitrifying, and strictly anaerobic conditions. Aromatic hydrocarbons were partially removed under aerobic conditions while tetrachloroethene and trichloroethene concentrations were greatly reduced within 12 days under both anaerobic and denitrifying conditions. These results are promising. They suggest that the natural degradative processes, perhaps acting in sequence and with some stimulation, may provide significant remediation of the sludges at the MacDougall site.

CP8

ENHANCED BIODEGRADATION OF AROMATIC AND CHLORINATED ALIPHATIC COMPOUNDS IN A LEACHATE-IMPACTED AQUIFER.

D.W. Acton*, M. Shaw, J.F. Barker, C.I. Mayfield, and J.A. Cherry, Waterloo Centre for Groundwater Research, University of Waterloo, Waterloo, Ontario, N2L 3G1.

Enhanced in situ biodegradation is a potential method of remediating groundwater contaminated by landfill leachate. This study investigated the enhanced biodegradation of aromatic and chlorinated aliphatic compounds in a methanogenic aquifer at a landfill site in North Bay, Ontario. Active microcosms were amended with remediating solutions of alternate electron acceptors (nitrate, peroxide) and primary substrates (acetate and glucose). Attenuation of organic compounds in remediated microcosms was compared to unremediated and sterile microcosms to assess the effectiveness of different remedial schemes. Losses in unremediated microcosms were attributed to natural biodegradation processes. For example, rapid loss of carbon tetrachloride and accumulation of chloroform was attributed to methanogenic reductive dehalogenation. Some of these removals have also been interpreted from organic compound distributions in the leachate plume. The addition of nitrate inhibited this process. However, significantly greater loss of aromatic compounds was observed in nitrate and peroxide remediated microcosms, compared to unamended controls. Acetate- and glucose-remediated microcosms showed no significant mass losses. The results indicate that enhanced biodegradation of some target compounds is possible in the North Bay aquifer by the addition of oxidizers. Additional small-scale field tests are underway to evaluate these remedial schemes. If encouraging, large-scale field evaluations will be conducted in 1989.

CP9

Waste Management Planning for Pharmaceutical Industry.

R. Makhija and R.A. Stairs Department of Chemistry,
Trent University, Peterborough, Ont. K9J 7B8

Abstract. A survey of pharmaceutical wastes generated by the industry in Ontario was carried out in the winter and spring of 1985-86, with subsequent follow-up. The purpose was to identify and quantify the various types of wastes generated and disposed of. Results based on replies from 35 of the 70 establishments approached are summarized. Seven recommendations are made, dealing with further research and development work and with proposed changes to regulations governing waste management practice.

SESSION D

ANALYTICAL METHODS

Oral Presentations

ANALYTICAL METHODS DEVELOPMENT RESEARCH

Ray Clement
Laboratory Services Branch
Environment Ontario

Virtually every aspect of environmental research requires sample analysis. Sound methodologies are required for studies of a wide range of organic and inorganic contaminants of drinking and surface waters, groundwater, landfill leachates, ambient air, stack emissions, hazardous wastes, sewage and pulp and paper sludges, and biological systems. In addition to developing new methods for performing qualitative and quantitative determinations at trace levels in complex matrices, there is a constant need to improve existing methods to allow for analysis of more samples, better and faster. Specific research needs cover the gamut of analysis steps from sampling to analyte identification, quantification, and data interpretation.

Research is needed in the analytical area to determine the effect of sampling protocols on analytical data, especially for microbiological parameters. Field methods for pre-concentration of viruses and integrative biological tests to identify problem areas in air, soil and water are required. Rugged field collection methods for large-volume aqueous samples are needed using sorbent cartridges or other means. Associated sample preservation, shipping and storage protocols to ensure analyte stability are equally important. Techniques for odorous compounds in water and air and non-open collection methods to avoid atmospheric contamination or degassing of groundwaters/landfill leachates are of special importance. A validated, tiered testing protocol for groundwater contaminants is also required, in addition to improved methods for semi-volatile organics and trace metals in ambient air. Cannister sampling methods, plume dispersion models and improved prediction of precipitation events are all required to improve air and atmospheric deposition studies.

Samples often must be sub-aliquoted for analysis of multiple analytes and round-robin investigations. Effects of grinding, slicing, blending and other mixing and homogenization procedures on sample integrity need to be performed. Determination of analyte losses and the potential for artifact introduction and sample cross-contamination are especially important. Procedures to ensure the homogeneity of aqueous samples containing suspended particulates during sub-aliquoting also require investigation. Laboratory protocols for recovery and enumeration of pathogenic organisms need to be developed.

An ongoing need is to improve methods for the unambiguous identification of a broad range of organics in complex samples such as pulp and paper and sewage sludges. Methods to be investigated include advanced GC-MS techniques, FTIR, computer library matching, and other chemometrics techniques. Isolation

and concentration methods to obtain large quantities of unidentified analytes are required to employ other spectroscopic techniques such as NMR. Improved chromatographic separation and HPLC fractionation techniques to simplify complex organic mixtures prior to mass spectrometry detection are also needed. Rapid screening methods for trace metals in aqueous samples by using ICP-MS, GC-microwave plasma emission, or biological on-line monitoring are also of interest.

Microbiological identification enhancements are required for E. Coli and group D. enterococci in water and sediments, as well as modification of such methods for the detection of other pathogens such as Salmonella and Compylobacteria. Similar methods to identify genotoxic compounds or conditions in the environment are needed. An ongoing problem is how to relate carcinogenicity and genotoxicity test responses to human health effects.

Improved quantification of target analytes is an ongoing research need. Development of novel GC detectors or improving the selectivity of conventional detectors is one approach to be considered. Development of improved cleanup techniques to isolate chemicals of concern also needs to be studied. the unambiguous determination of all 2,3,7,8-substituted dioxin/furan congeners is of special interest. To improve the quantitative analysis of selected target analytes in specific matrices, research is needed to develop validated analytical standards and SRMs.

For all of the preceeding studies improvement of sample throughput and the analytical precision and accuracy are desired. Approaches include chemometric techniques for data analysis including development of expert systems for data analysis, QA/QC, and troubleshooting analytical instruments. Other enhancements can be obtained through the use of robotics and development of new sample preparation methods more suited to automation. One area of special interest is the extraction/concentration of samples using supercritical fluids.

In addition to all of the above, some critical Ministry programs have special requirements. Of particular importance are laboratory techniques to assess the leaching potential of specific wastes for hazardous waste classification. Methods for complex industrial effluents for the MISA program are also important. Specific research is required to evaluate interferences for the determination of inorganics in MISA effluents, to develop improved analyte detectability by matrix modification, and to improve and validate methods for quantifying volatiles associated with liquid and solid fractions of sludges. Special problems have been encountered with the complex samples derived from pulp and paper industries, for which research is needed for sediment and biota tissue analysis of resin and fatty acids and speciated phenols. In addition, methods for flowthrough field analysis of pulp and paper effluents to determine the impact of mill discharges are required. Research is also needed to develop methods for the source tracking of pollutants in air and water. Chemometric methods are needed to compare organic/inorganic analyte profiles to identify generic sample types, to identify specific sources of such groups of compounds as PCBs, dioxin/furans and toxaphene by studying their congener/isomer patterns, and by studying isotope ratios of elements such as lead.

D1

ANALYTICAL CHEMISTRY IN A REGULATORY ENVIRONMENT;

R. Kagel, Dow Chemicals, Midland, Michigan, U.S.A.

SEE ANALYTICAL METHODS RESEARCH SESSION D PROCEEDINGS BOOK FOR THE EXTENDED ABSTRACT.

D2

ADAPTION OF WATER PRECONCENTRATION TECHNIQUES DEVELOPED FOR PCDD ANALYSIS TO OTHER TARGET ORGANIC POLLUTANTS. E. Dowdall*, B. R. Hollebone, L. Brownlee, C. Shewchuk, Carleton University, Ottawa, Ontario, K1S 5B6

To simplify drinking water analysis by the Ontario Ministry of the Environment, this laboratory has produced an automated preconcentration sampler. The analysis of its detachable filters and XAD columns for trace level contaminants using existing technology would require large quantities of extracting solvents to be used in a soxhlet apparatus. Such a process is labour intensive and requires long operating times to facilitate the extraction of the adsorbed compounds. Supercritical fluid technology would eliminate these problems. Specific characteristics of supercritical fluids allow efficient extraction using comparatively small volumes in a mostly automated system. The extraction manifold can be designed to collect and recirculate the extracting medium. These features allow solvent costs and extraction times to be dramatically reduced while maintaining comparable extraction yields. A receptor vessel, built to accommodate the entire filter housing or column, will eliminate human contact with the filters thereby creating greater analytical accuracy. Frequently, carbon dioxide is the solvent of choice for supercritical fluid extraction. Experimentation will decide which solvent or solvents and operating parameters will be best suited to extract the organic pollutants selected by the Ministry of the Environment as high priority concerns.

D3

THE PURPOSE AND SIGNIFICANCE OF ULTRATRACE ANALYSIS OF DIBENZO-P-DIOXINS: THE CONCEPT OF RISK. L. Brownlee* and B.R. Hollebone, Chemistry Department, Carleton University, Ottawa, Ontario, K1S 5B6.

These laboratories in conjunction with the Ministry of the Environment have developed a preconcentration sampler capable of identifying ultratrace (ppq) levels of dibenzo-p-dioxins in natural and treated waters. This methodology will be extended to include other persistent chlorohydrocarbons. The ultimate goal of this work is to obtain a large data base of exposure levels of these chemicals throughout Ontario. As the public becomes better informed about environmental management, the interpretion of this data base in relation to population health risks from chemicals will become important. The health RISK from each chemical can be described as the mathematical product of EXPOSURE X HAZARD. Exposure can be calculated from the analytical data obtained by the preconcentration sampler. Hazard can be defined as a long term degradation of health from acute or chronic chemical exposure. It can be quantitated by experiment or epidemiology for any disease condition. Using the hepatic Mixed Function Oxidase system we have developed a model of hazard which has potential as a screening procedure for chemically induced disease. The implications of this model in determining the potential risk of the MOE data base, with emphasis on dioxins will be discussed.

D4

PROCEDURES FOR THE ANALYSIS OF 2,3,7,8-SUBSTITUTED PCDD & PCDF ISOMERS & OTHER TARGET COMPOUNDS IN ENVIRONMENTAL SAMPLES. F.W. Karasek*, T.S. Thompson and K.P. Naikwadi, Department of Chemistry, University of Waterloo, Waterloo, Ontario N2L 3G1.

It has been found that PCDD and PCDF having 4 to 6 chlorines and the 2,3,7,8-substitution pattern exhibit higher toxicity than the remaining isomers. Isomer specific analyses have been reported for the determination of the most toxic PCDD and PCDF, 2,3,7,8-TCDD and 2,3,7,8-TCDF, in a variety of sample matrices. The goal of this research was to develop HPLC procedures which would permit the unambiguous identification and quantitation of the twelve most toxic PCDD and PCDF. The HPLC cleanup methods employed serve a two-fold purpose: 1) the PCDD and PCDF are isolated from the bulk of the sample matrix including interfering components and 2) fractionation of the PCDD and PCDF isomers into several groups permits subsequent isomer specific analysis by GC-MS. A dual HPLC fractionation procedure consisting of a silica normal phase separation followed by an alumina normal phase subfractionation was devised. A complex mixture of organic compounds including virtually all PCDD and PCDF isomers is found adsorbed on the surface of fly ash. Thus a fly ash extract was the ideal matrix for testing the efficiency of the methodology developed.

D5

THE CLOSED-LOOP STRIPPING TECHNIQUE, APPLIED TO POTABLE WATER TO SOLVE TASTE AND ODOUR PROBLEMS.

J-P. Palmentier*, D. Robinson and V. Taguchi.
Ontario Ministry of the Environment, Laboratory Services Branch, DWO-MSU, P.O. Box 213, Rexdale, Ontario M9W 5L1

The occurence of objectionable taste and odour problems in potable water is mainly a seasonal problem. Water treatment plants require the analysis of water for these problem compounds so that action can be taken to stop the problem as quickly as possible. These compounds have threshold levels in the low ng/L region and are below the detection limits of some instrumentation. A Closed-Loop Stripping technique followed by gas chromatography-mass spectrometry is being used to analyze for geosmin and 2-methylisoborneol along with other taste and odour causing compounds. A study showing the comparison of a solvent extraction technique with thermal desorption for the extraction of these organic compounds from adsorbent traps will be discussed.

D6

SOLID SUPPORTED PROCESSES IN ENVIRONMENTAL ANALYSIS. J.M. ROSENFELD Department of Pathology McMaster University. Hamilton, Ont. L8N-3Z5

We investigated solid supported reaction and separation process to simplify and automate analytical procedures. The intent was to improve quality control and reduce both turn around time and costs.

Reactions on supports of XAD-2 produced highly electrophoric pentafluorobenzyl derivatives of chlorophenoxy alkyl acid herbicides and corresponding phenols. Emphasis was on optimization of both reaction conditions and chromatographic procedures to separate the derivatized analytes from interfering compounds.

Optimization of reaction conditions was dependent on treatment of resin and control of pH. The former was standard for derivatizations of polar compounds. Effect ot pH on the reaction profile was atypical for the general class of carboxylic acids and phenols but conditions for reaction of both the chlorophenoxy carboxylic acids and phenols were found. Development of separations required study of: (a) methods for efficient transfer of derivatives from the XAD-2 reactor bed to chromatographic column; (b) proper chromatographic phase. Efficient transfer was affected by chemically drying the resin bed with a water scavenger and eluting the analytes with from the resin to the chromatographic column with non-polar solvents. Basic alumina and florisil were investigated and elution profiles developed. The sensitivity of procedures was reduced to 10 nG/mL and further reduction of sensitivity appear to require improved gas chromatographic conditions.

D7

SYNTHESIS AND USE OF LIQUID CRYSTALLINE POLYSILOXANE SUBSTRATE IN CAPILLARY COLUMN GC-MS FOR ISOMER SPECIFIC SEPARATION OF TOXIC ISOMERS OF PCDD AND PCDF. K. P. Naikwadi* and F. W. Karasek, Department of Chemistry, University of Waterloo, Waterloo, Ontario, N2L 3G1.

The synthesis and characterization of a variety of mesomorphic (liquid crystalline) side chain polysiloxane substrate known to be useful as gas chromatographic stationary phases , are described and discussed. The synthetic scheme is based upon the hydrosilation reaction that occurs when precursor liquid crystalline alkene compounds are contacted with polymethylhydrosilane in the presence of platinum catalyst. Liquid crystalline polysiloxane offer unique selectivity when used as stationary phase in capillary gas chromatography. Separation on such column occurred based on the size and shape of the solute molecules. Separation and quantitation of the most toxic isomers of polychlorinated dibenzo-p-dioxins (PCDD) and dibenzofurans (PCDF) generally requires the use of long polar capillary columns, that are inadequate for analysis of total PCDD, PCDF. However, liquid crystalline polysiloxane capillary column shows unique selectivity for separation of 2,3,7,8-TCDD and TCDF, and analysis of total PCDD and PCDF in same GC-MS run can be carried out. Advantages of liquid crystalline polysiloxane capillary column over conventional capillary columns used in analysis of PCDD and PCDF will be discussed.

D8

DEVELOPMENT OF MOBILE INFRARED SPECTROSCOPY FOR ON-SITE SPECIATION OF ORGANIC WASTES

P. Yang* and J. Osborne, Ministry of the Environment, Laboratory Services Branch, Trace Organics Section, 125 Resources Road, Rexdale, Ontario M9W 5L1, Canada

The mobile unit of the Ontario Ministry of the Environment is equipped with state-of-the-art analytical instrumentation to perform on-site analysis of hazardous wastes for prompt remedial action and solve environmental problems. In order to increase the field capacity in the classification and identification of hazardous wastes and to provide rapid turnaround-time capability, the unit is evaluating the suitability of a fourier transform infrared spectrophotometer (FT-IR) for the mobile laboratory. Three commercial FT-IR spectrophotometers have been evaluated for (1) the stability of their basic optical components, (2) the ease of adapting extra sampling accessories, and (3) the versatility of the data system. Algorithms employed to facilitate the classification of various wastes would be illustrated. Real time analysis of samples are performed on-site. The results demonstrate that IR spectroscopy when used concomitantly with appropriate algorithms can fulfill the desired goals. The development of an IR library of environmental pollutants that allows an efficient screening of organic wastes will be discussed. Future plans for remote sensing of industrial emissions which generate harmful species, will also be discussed.

D9

MOBILE LABORATORY: ON THE DEVELOPMENTAL AND REAL WORLD APPLICATION ASPECTS

D. Toner*, B. Dalton, D. Morse, K. Ham, P. Yang and J. Osborne, Ministry of the Environment, Laboratory Services Branch, Trace Organics Section, 125 Resources Road, Rexdale, Ontario M9W 5L1, Canada

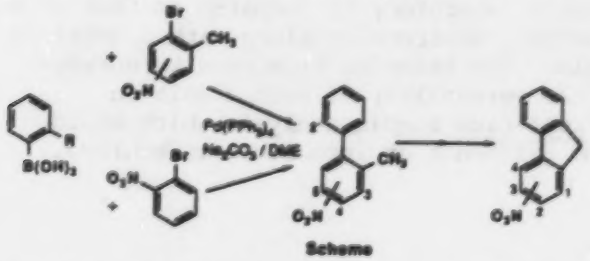
A mobile laboratory is useful for on-site remedial action of chemical spills, screening incoming organic and inorganic wastes at licensed disposal facilities, industrial hygiene monitoring and, as a result of these actions, legal enforcement. For the past three years, the Trace Organics Section of the Laboratory Services Branch at the MOE has engaged in the development of a mobile laboratory to achieve the first two goals. Practical apparatus such as a flash point analyzer as well as the state-of-the-art instrumentation (e.g., capillary GC, GC/MS and FT-IR) have been integrated into our mobile laboratory. Qualitative/quantitative target compound analysis and classification and/or identification of unknown samples can be carried out in the field. We present in this report established criteria for effective equipment implementation and operation of a mobile laboratory. The precision and accuracy of results from the mobile laboratory is compared to that of a normal laboratory environment along with a detailed cost analysis. The examples from on-site surveys illustrate the versatility of such a unit in performing real-time sample analysis which would otherwise be difficult or impossible to achieve.

D10

REGIOSPECIFIC SYNTHESES OF ALL ISOMERIC NITROFLUORENONES AND NITROFLUORENES BY TRANSITION METAL CATALYZED CROSS COUPLING REACTIONS. V. Snieckus*, T. Iihama, J.-m. Fu, M. Bourguignon, Guelph-Waterloo Centre for Graduate Work in Chemistry, University of Waterloo, Waterloo, Ontario N2L 3G1

Nitro-PAH are environmental pollutants which have been increasingly detected in urban ambient air particulates, diesel exhaust emissions, fly ash, photocopier fluids, and cigarette smoke. The accumulating evidence of their wide environmental distribution and potent directing acting mutagenicity has prompted intense activity in the nitro-PAH area. These studies require the availability of high purity analytical standards for the detection, identification, and quantitation of nitro-PAH and their metabolites.

As part of a comprehensive program in nitro-PAH synthesis, we report on a new regiospecific approach to all isomeric nitrofluorenes using transition metal catalyzed cross coupling methodology recently developed in our laboratories. 1-, 2-,3-, and 4-nitrofluorenes and the corresponding nitrofluorenones have been obtained as single isomers thereby precluding extensive separation from other isomers as is required in the classical syntheses. Details of this route (Scheme) will be presented, analyzed, and compared with previous methods of synthesis. The synthesized nitrofluorenones will also serve as intermediates for the preparation of nitrofluoranthenes and work in this direction, currently in progress, will be presented.



Scheme

We are grateful to the Ontario Ministry of the Environment for the support of this research (Project 304PL).

D11

PREPARATION OF HETEROCYCLIC POLYNUCLEAR AROMATIC COMPOUNDS AS ANALYTICAL STANDARDS. E. Lee-Ruff*, B.E. George, F.J. Ablenas and Y.S. Chung, Department of Chemistry, York University, 4700 Keele Street, North York, Ontario M3J 1P3

We have developed a program for the expedient synthesis of novel sulphur and oxygen heterocyclic derivatives and the provision of these as analytical standards to the MOE. The routes to these heterocycles involve synthetic methods developed in our labs using cyclobutanones as key intermediates. This method has now been extended towards the preparation of aza-heterocyles and mixed aza-sulphur heterocycles. A number of these have been preliminarily screened using the Ames assay and exhibit varying levels of mutagenic activity. The specific sulphur and aza heterocycles will be described along with their synthetic details. Spectroscopic data used for their structural assignments will also be included.

D12

APPLICATION OF ICP SPECTROMETRY IN HEALTH AND ENVIRONMENT: A CASE STUDY OF SOIL INGESTED BY CHILDREN; R. Barnes, University of Massachesetts, Amherst, Massachusetts, U.S.A.

SEE ANALYTICAL METHODS RESEARCH SESSION D PROCEEDINGS BOOK FOR THE EXTENDED ABSTRACT.

D13

DIRECT SAMPLE INSERTION INTO AN INDUCTIVELY COUPLED PLASMA FOR ATOMIC EMISSION AND MASS SPECTROMETRY. L. Blain* and E.D. Salin, McGill University, Department of Chemistry, 801 Sherbrooke St. W., Montreal, Quebec, H3A 2K6.

The need for a reliable technique that permits the direct analysis of solid samples is now well recognized. In many instances, the direct insertion of these solid samples in the ICP for their analysis by AES or MS seems the most promising approach. Among its advantages are that it can be readily retrofitted to already existing commercial instruments, as well as its ease and rapidity of operation. We will report on an automated stepper motor driven design for the Direct Solid Sample Introduction Device (DSID) and its use with pressed pellets. Detection limits for many elements in the solid are now sub ppm for atomic emission and are, for Pb, sub ppb. The advantages and disadvantages of the pellet technique will be discussed.

D14

Analysis of Germanium and Tin by Hydride Generation D.C. Plasma Atomic Emission Spectrometry. Application to Determinations of Germanium and Tin in Air Filters.

I.D. Brindle*, B. Buchanan, and X.-c. Le, Chemistry Department, Brock University, St. Catharines, Ontario L2S 3A1

The determination of hydride forming elements in complex matrices can be difficult. Interference from a number of transition elements can reduce or eliminate signals from hydride forming elements. This paper describes our work on the reduction of these interferences. Through the use of L-cysteine and/or L-cystine, low levels of germanium and tin can be determined in, for example, standard reference materials such as iron and copper. Interference from matrix elements is effectively eliminated. Detection limits for both germanium and tin is 20 pg ml^{-1}. The application of this method to the analysis of air filters will be described.

D15

USE OF THE HOT SLURRY TECHNIQUE FOR SOLID SAMPLE INTRODUCTION FOR ICP-AES. L. Gervais* and E.D. Salin, McGill University, Department of Chemistry, 801 Sherbrooke St. W., Montreal, Quebec H3A 2K6.

Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) is now used for a large variety of materials once transformed into an aqueous format. Because of lengthy aqueous sample preparation requirements, slurry based methods have been studied to circumvent long sample processing times. We will discuss the use of a heated Babington type sample introduction system for the analysis of slurries. The system provides a signal level increase of a factor of 6.5. Signal-to-Noise, detection limits and efficiencies will be discussed as well as details on the studies performed for the analysis of trace elements in marine sediments will be given.

D16

ADVANCED TECHNOLOGY FOR DESTRUCTION OF WATERBORNE ORGANIC POLLUTANTS

Hussain Al-Ekabi* and Mike Robertson, Nulite, A Division of Nutech Energy Systems Inc., 317 Consortium Court, London, Ontario N6E 2S8

The presence of organic pollutants (particularly chlorinated) in both natural and drinking waters represents a serious environmental problem both in North America and Europe. While thermal, chemical, photochemical and microbiological processes can degrade these pollutants, they are either difficult to apply to the disposal of these waterborne pollutants or require long treatment periods. Obviously, efficient technology must be found for the degradation of these pollutants.

At Nulite, we are developing an advanced technology for water treatment. This technology depends on the TiO_2 photoassisted catalytic mineralization of the organic pollutants. A prototype reactor consisting of a near UV lamp surrounded coaxially by a glass substrate to which a thin anatase layer is firmly bonded was fabricated by Nulite. The TiO_2 film was characterized by a variety of surface techniques. The performance of the prototype reactor towards destruction of several organic pollutants was proven efficient. Results will be presented.

D17

DEVELOPMENT OF *ACexpert*. 2. IMPLEMENTATION OF AN EXPERT SYSTEM FOR AUTOMATED METAL ANALYSIS BY ATOMIC ABSORPTION SPECTROSCOPY.

Martin J. Stillman*, Timothy A. Cox and William R. Browett, Department of Chemistry, University of Western Ontario, London, Ontario, N6A 5B7.

We describe the implementation of components of the expert system *ACexpert*. This system will be used to control all aspects of metal ion analysis carried out by the technique of atomic absorption spectrometry (AAS). We have developed a model of the flow of information in the analytical laboratory that shows both manual and automated patterns. *ACexpert* provides an environment within which the manager, analyst, and analytical instruments, all interact to complete the analysis. As we envisage *ACexpert* in the analytical laboratory, the CUSTOMER and MANAGER will begin by using the *ACassurance* expert system to assist them in selecting the appropriate methods and analysis criteria that are consistent with the requirements of the REGULATORY AGENCY and the capabilities of the laboratory. The analysis criteria and recommended methods would then be available to *ACexpert*, for use in the selection of the specific chemical and instrumental procedures and "standard methods" that are to be used by *ACcontrol* to complete the metal determination of each sample. In normal operation, the ANALYST would confirm the method selected by *ACexpert* was acceptable and monitor the performance of the automated analyses that would be carried out by *ACcontrol*. The initial stages of the research required the complete control of the analytical instrument, the AAS, and full solution capability, this is achieved in *ACcontrol*.

D18

ADAPTATION OF WATER PRECONCENTRATION TECHNIQUES OF TRACE METAL DETECTION. K.L. Singfield* B.R. Hollebone, L.J. Brownlee, Department of Chemistry, Carleton University, Ottawa, Ontario K1S 5B6, P. Vijan, Laboratory Services Branch, MOE.

Part of the responsibility of the Ontario Ministry of Environment in maintaining drinking water quality is the detection and quantitation of potentially toxic metals in raw and treated waters. These target metals include Al, Ba, Cr, Co, Fe, Pb, Mn, Hg, Mo, Ni, Sr, Va, and Zn. Current grab sample methodology limits the concentration of the sample to a 20 fold increase and does not provide for the removal of the undesirable, highly concentrated calcium, magnesium, sodium, and potassium ions which cause matrix interferences in the final ICPES analysis. The objectives of this project are (i) to preconcentrate the heavy metals in the field while separating them from the interfering ones and, (ii) to improve the existing limits of detection of these target metals. To meet these objectives, a preconcentration water sampler for trace metal detection is currently being developed based on the adaptation of an existing preconcentration water sampler for organics. This sampler was developed in these laboratories and is capable of preconcentrating 100 L of water in duplicate, under fully automated conditions. The sample stream from any source is split, analytically filtered, then passed through adsorption columns. Columns packed with chemically modified commercially available resins provide an adsorbing medium for the target metals while providing an eluting medium for the undesirables. Examples of system performance will be given.

D19

COMPARISON OF VARIOUS LEACHATE EXTRACTION PROCEDURES FOR THE CHARACTERIZATION OF INORGANICS IN WASTES. J.R. Kramer*, P. Brassard, J. Gleed and P.V. Collins, Department of Geology, McMaster University, Hamilton, ON L8S 4M1

The Ontario Ministry of the Environment Leachate Extraction Procedure (LEP) is a legislated protocol (Regulation 309) for the determination of toxicity of a waste. This research determines the effect of change in parameters upon results from LEP and compares results of LEP to other extraction procedures. Differences are related to the nature of the waste and chemical concepts. Comparison of (LEP), a sequential leachate extraction procedure (SEQ) and continuously pH buffered extraction (BUF) was made. In general, the BUF gave values similar to steps I and II (ion exchange and acetic acid extraction) of SEQ, and both gave leachate concentrations significantly higher than the LEP. Results were especially different when pH sensitive substrates (e.g. Fe (hydr)oxides, Ca-carbonate) were present. This suggests that many of the trace substances are intimately associated with these phases. The LEP and BUF were assessed as to variation in results as a function of sediment concentration, length of extraction and pH. Different patterns resulted. Increasing particle concentration resulted in both increased and decreased solute metal concentration, probably due to particle-particle interaction (increasing solute) and surface re-sorption (decreasing solute). pH had a pronounced affect on all solute results, and in general, solute concentration increased as pH decreased. A pH of 5 (e.g. LEP) is often the threshold for marked increase of solution metal concentrations. Metal concentrations as a function of time tend often to reach a steady state value within the 24 h as specified by LEP. There are exceptions, however, when marked increases in metal occur, indicating a new solid-solute reaction. Recommendations for characterization by the LEP or similar method include a) assessing the effect of different particle concentrations (emphasize increasing values), b) assessment of different pH levels (4,5,6,7), and c) determination of metal solutes as a function of time up to 100 h. A protocol for assessing pH, particle concentration and time of leaching is proposed.

D20

2,4-DICHLOROPHENOXYLACETIC ACID (2,4-D) DETERMINATION IN WATER, URINE AND SOIL EXTRACTS BY ENZYME IMMUNOASSAY (EIA) AND RADIOIMMUNOASSAY (RIA). J.C. Hall* and K. Krieg, Dept. Environmental Biology, University of Guelph, Guelph, Ontario N1G 2W1

Polyclonal antibodies were developed with specificity to 2,4-D for use in an EIA and RIA system. To produce antibodies against the herbicide, rabbits were immunized with a conjugate of 2,4-D and bovine serum albumin (BSA), which was prepared by converting the herbicide to an anhydride by reaction with dicyclohexyl carbodiimide followed by slow addition of the reaction product to a solution of BSA/dimethylformamide/water. Rabbits were injected subcutaneously with a solution of 1 mg of immunogen in 0.4 ml of PBS and emulsified with an equal volume of Freund's complete adjuvant. The resulting antisera showed a high specificity toward the dichlorophenoxy moiety of the herbicide, which was demonstrated by the determination of cross reactivities with structurally related compounds such as MCPA, 2,4-DB, 2,4-DP, MCPB, dicamba, and 2,4,5-T. The highest cross reaction was obtained with 2,4,5-T. An indirect EIA method was used for detection of 2,4-D and involved: i) passive binding of a 2,4-D/BSA conjugate to the surface of polystyrene microtitre plates; ii) addition of 2,4-D antisera with or without 2,4-D to be quantitated; iii) addition of goat anti-rabbit IgG conjugated to alkaline phosphatase; iv) addition and conversion of substrate; and v) colour determination at 405 nm. Colour development occurs in indirect proportion to the concentration of free 2,4-D. Unknown quantities were determined from a standard curve of known herbicide concentrations versus colour intensity. RIA was developed by conjugating ^{3}H-glycine (sp. act. 60 Ci/mmol or 2.22 GBq/mmol) to 2,4-D using a mixed anhydride reaction. The radiotracer was incubated with a solution containing antisera and various quantities of free 2,4-D. After incubation, the antibodies were precipitated and the quantity of radioactivity in the pellet was quantitated. The quantity of radioactivity in the pellet was in indirect proportion to the quantity of free 2,4-D. The least amount of 2,4-D that could be detected by both RIA and EIA was 5 ng/100 ul of undiluted and unaltered river water or urine. If the 2,4-D present in urine or river water samples was concentrated by solvent extraction and column chromatography the least quantity of 2,4-D that could be accurately detected was increased by at least 100 fold.

SESSION D

ANALYTICAL METHODS

Poster Presentations

DP1

DERIVATIZATION OF ACIDIC ORGANIC COMPOUNDS USING PHASE TRANSFER CATALYSIS. V.Y. Taguchi* and O.W. Berg,
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M9W 5L1

Acetylation is a common procedure that is used to derivatize acidics such as phenols so that they can be analyzed on gas chromatographic columns that have been designed to analyze base/neutrals. It relies on the nucleophilicity of the phenol and the electrophilicity of the acetylating agent. Phase transfer catalysis or extractive alkylation relies on formation of an ion pair between the anion of the phenol and a quaternary ammonium cation. This ion pair is soluble in both the aqueous and the organic phases. When an alkylating agent such as methyl iodide is present in the organic phase, irreversible alkylation occurs. Because the alkyl ethers are formed instead of esters derivative stability should be enhanced. Application of phase transfer catalysis to the analysis of acidic organic compounds is presented as an alternative to classical techniques such as acetylation.

DP2

NEW CHEMICAL IONIZATION REAGENTS DIRECTED TOWARD MASS SPECTROMETRIC ANALYSIS OF TRACE ORGANICS.

T.B. McMahon*, K. Froese and C.E. Allison, Department of Chemistry and Guelph-Waterloo Centre for Graduate Work in Chemistry, University of Waterloo, Waterloo, Ontario N2L 3G1

Polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), dioxins and dibenzo furans are environmentally important compounds typically analyzed by mass spectrometric methods. In order to maximize the accuracy of quantitative analysis and lower detection limits by GCMS techniques it is highly desirable to use ionization techniques which maximize intensity in molecular or quasi molecular ions. Both electron impact and traditional chemical ionization methods frequently lead to extensive fragmentation effectively obscuring molecular formula information and resulting in many ions of low intensity instead of a few or a single ion of higher intensity. Using Fourier Transform Ion Cyclotron Resonance techniques (FTICR) we have developed an extremely "soft" negative chemical ionization method which leads to no fragmentation of the newly formed quasi molecular anion. This technique based on chloride donation from a chloride transfer reagent ion derived from negative ion-molecule reactions in ethylchloroformate has been shown to be potentially useful for each of the above compound classes. Results obtained for model compounds and potential analytical applications will be discussed.

DP3

AN INTERRUPTED SEGEMENTED FLOW STREAM MICROWAVE SOLID SAMPLE DECOMPOSITION FOR ICP-AES. E .D. Salin* and B. Liu, McGill University, Department of Chemistry, 801 Sherbrooke St. W., Montreal, Quebec H3A 2K6.

A long-standing problem in elemental analysis has been the requirement for liquid samples for many instrumental methods. The research for a rapid dissolution technique has led many workers to investigate the use of a microwave oven as a digestion aid. We have investigated the use of a microwave oven for stream rather than bomb digestion of solid samples. This would enable essentially constant sample digestion and should drastically reduce sample processing time. Using a target sample of copper ore, the microwave system will digest the sample in approximately 3 minutes while normal conditions require 30 minutes. The design, use and performance of the prototype system will be discussed with respect to the possibily of generating a flowing stream continuous system.

DP4

SOLID PHASE EXTRACTION OF PAHS FROM DRINKING WATER AND ANALYSIS OF CHLOROPHENOLS AND PHENOXY-ACID HERBICIDES IN WATER. W.G. Craig* and C. D. Hall, Paracel Laboratories Ltd., Nepean, Ontario, K2G OG3.

The use of solid phase extraction columns in the analysis of polyaromatic hydrocarbons in water is being investigated. The study includes the examination of alternate company's products, solid phases, water matrices, eluting solvents, methods of reducing interferences and storage conditions. The use of solid phase extraction for the analysis of chlorophenols and phenoxy-acid herbicides in water was previously shown to be useful and this technique is being investigated in greater detail with particular emphasis being placed on determining the ruggedness of the method, reducing interferences and improving the recoveries. The current method for analyzing chlorophenols and phenoxy-acid herbicides involves derivatization with diazomethane. Alternative methods of derivatization are being studied.

DP5

AUTOMATED WATER PRECONCENTRATION SAMPLER FOR DIOXIN DETECTION AT THE PARTS PER QUADRILLION LEVEL. C. Shewchuk*, B. Hollebone, L. Brownlee, E. Dowdall, Carleton University, Chemistry Department, Ottawa, Ontario, K1S 5B6; R. Hunsinger, M. Uza, MOE, Water Resources Branch; and H. Tosine, S. Suter, MOE, Laboratory Services Branch.

The Ministry of the Environment is responsible for a monitoring program for contaminants in drinking water. It is necessary to be able to detect and quantify accurately ultratrace levels of highly toxic classes of chlorinated dibenzo-p-dioxins (CDD's) and chlorinated dibenzofurans in the environment. A sampling unit capable of preconcentrating 100 L water sample for analysis of CDD's/CDF's at the ppq level was designed. This unit contains a filtering system to collect particulate matter and columns containing XAD resin to adsorb dissolved organics, both of which can be removed for analysis. The manufacture of the prototype sampler has been completed and it is currently undergoing testing by MOE. Results of laboratory and preliminary field studies will be presented.

DP6

AUTOMATED HPLC METHOD FOR LOW LEVEL POLYNUCLEAR AROMATIC HYDROCARBON (PAH) ANALYSIS OF DRINKING WATERS.

P.W. Crozier* and C.D. Hall, Laboratory Services Branch, Ministry of the Environment, Rexdale, Ontario M9W 5L1

More emphasis is being placed on the analysis of PAHs in drinking waters due to their discovery in routine monitoring programs at select locations in Ontario. The implementation and expansion of sampling programs such as DWSP and MISA has necessitated the development of automated low level analytical techniques.

PAH production is generally associated with coal/oil/gas burning power plants and combustion engines as well as steel manufacturing and petrochemical industries. In nature PAHs are produced by combustion of organic matter under conditions of insufficient oxygen and/or low combustion temperature. Various members of this chemical class have been shown to be carcinogenic to animals with several suspected carcinogens for man.

The automated HPLC method scans for 17 individual PAHs with the most important ones for monitoring purposes being fluoranthene, benzo(b) fluoranthene, benzo(k) fluoranthene, benzo(a) pyrene, benzo(ghi) perylene and indeno(123cd) pyrene. Wet chemical preparation involves liquid/liquid extraction followed by a three stage concentration and solvent exchange. Instrumental analysis is done by reversed phase HPLC using a programmable fluorescence detector system. Method detection limits range from 1 ng/L for anthracene and benzo(k) fluoranthene to 50 ng/L for benzo(e) pyrene and chrysene. Average recoveries were >75% for most compounds with the exception of anthracene, benzo(a) pyrene and dimethylbenz(a) anthracene. Further work is being done to improve method detection limits and recoveries. Reducing instrument analysis time is also being investigated.

DP7

SUPERCRITICAL FLUID EXTRACTION OF TRACE ORGANICS FROM SOLID MATRICES

P. Kruus and R.C. Burk*, Department of Chemistry, Carleton University, Ottawa, Ontario K1S 5B6, Canada

and

G. Crawford, Ministry of the Environment, Laboratory Services Branch, Trace Organics Section, 125 Resources Road, Rexdale, Ontario M9W 5L1, Canada

In the analytical determination of trace organic compounds, the extraction step is often the most labour intensive and time consuming. Conventional extraction techniques using liquid solvents also suffer from a lack of selectivity and the need to concentrate the extract before instrumental analysis. Supercritical fluids have already shown promise in the extraction of organics from environmental solids. The advantages of using supercritical fluids arise from their unique set of physical properties. Their densities are liquid-like, while their viscosities are much lower than those of liquids. Extractions using supercritical fluids are thus faster than those using liquid solvents. Supercritical fluids have the unique property that their densities vary greatly with pressure. This allows one to vary the solvating power of the fluid by changing the pressure, and thus the extraction can be somewhat selective. The fluid can be further modified by adding a small amount of an organic co-solvent. Specific interactions between the solutes of interest and the co-solvent can lead to increased recoveries and selectivities. This research project is aimed at determining the most suitable apparatus, solvent systems and operating conditions for extracting trace organics from environmental solids for subsequent analysis.

DP8

AUTOMATED SAMPLE INTRODUCTION AND PRE-TREATMENT WITH FLOW INJECTION-ICP-ES. J. F. Hopper*, F. Mo, and D. W. Boomer, Laboratory Services Branch, Ontario Ministry of the Environment, Box 213, Rexdale, Ontario, M9W 5L1

ABSTRACT WITHHELD

DP9

APPLICATIONS OF FLOW INJECTION TECHNOLOGY TO ICP-MS. M.J. Powell*, J. F. Hopper, and D. W. Boomer, Laboratory Services Branch, Ontario Ministry of the Environment, Box 213, Rexdale, Ontario M9W 5L1

Flow injection equipment has been added to an ICP-MS instrument for evaluation as an alternative sample introduction system. The transient nature of the signal can significantly reduce sample matrix effects, but sample dispersion must be well-characterized and reproducible for reliable results. Response profiles have been generated for critical parameters affecting dispersion. The overall system is a cost-effective means of expanding the applicability of ICP-MS to different sample types, often with improved instrument performance. Additional advantages of combined Flow Injection-ICP-MS include on-line sample pre-treatment for species separation, pre-concentration, or dilution. Examples of applications to the measurement of major and trace species in environmental waters and in industrial wastes are presented.

DP10

INVESTIGATION OF THE IN-SITU ACETYLATION PROCESS AND ITS APPLICABILITY TO THE ANALYSIS OF A WIDE RANGE OF PHENOLIC COMPOUNDS IN WATER

R. Lega*, O. Meresz and M. Savu, Ministry of the Environment, Laboratory Services Branch, Trace Organics Section, 125 Resources Road, Rexdale, Ontario M9W 5L1, Canada

In-situ acetylation is receiving increasing attention in organic trace analysis. It is an elegant and simple technique that in one step achieves derivatization for gas chromatographic analysis and improves recoveries of phenolic compounds from aqueous matrices. A systematic study is presented on the effects of reaction conditions in this process. Experiments were run in the presence or absence of a water immiscible solvent during acetylation at different reagent (acetic anhydride) buffer and catalyst concentrations. Substrates consisted of more than thirty phenolic compounds (including some dihydric phenols and their chlorinated derivatives) mainly related to pulp and paper process effluents. The acetylated phenols were analysed using dual capillary column gas chromatography - flame ionization detector. A number of acetylated phenols were synthesized and purified for analytical standards. The optimized analytical method is presented.

DP11

ROBUSTNESS OF THE STUDENT'S T TEST WITH CENSORED ENVIRONMENTAL QUALITY DATA. E.E. Creese, Creese Environmental Consulting, P.0. Box 91, Waterloo, Ontario N2J 3Z6

Frequently when chemical parameters of environmental concern (e.g. chlorinated organics or heavy metals) are measured, a sample will contain replicates giving results both above and below the analytical detection limit. Such a set of replicates is termed a 'censored' data set. The object of this research is to assess the reliability of the Student's t test when it is extended to censored data. Previous studies (Gilliom & Helsel, Water Resources Research 22:135, 1986; Helsel & Gilliom, Water Resources Research, 22:147, 1986) have shown that, of the methods that they investigated, log-probability regression to a Gaussian curve was the most robust for estimating the mean and standard deviation of parent populations of environmental data. This research will use Monte Carlo methods to compare that method with log-probability regression to the curve of a t distribution, which is expected to be more precise with small sample size. It is expected that this evaluation will be completed for presentation. Once a method of log-probability regression is chosen, sample means and standard deviations can be estimated and used in Student's t tests. Monte Carlo evaluation of the robustness of the t test can then begin. Samples will be drawn from a known log-normal population. Sample mean and population mean will then be compared by t test, giving nominal Type I error rates. Actual Type I error rates will be obtained as a result of the repetition implicit in Monte Carlo methods. El Shaawari and his group at the Canada Centre for Inland Waters in Burlington, Ontario, have developed a method for dealing with censored data sets, based on the Maximum Likelihood approach. In the future an evaluation and comparison of their method with the one presented here will be required.

DP12

AUTOMATION OF SOLID SUPPORTED REACTIONS BY ROBOTICS.
J.M. Rosenfeld and E. Pevolinas Departments of Pathology and Engineering Physics, McMaster University. Hamilton Ont. L8N-3Z5

Automation is a necessary development for environmental laboratories which more than any other organization are required to analyze numerous samples and under time pressure. Solid supported processes have been suggested as an approach to the automation of analytical methods. We have studied and developed a prototype robotic system as the basis for incorporating such reactions into automated methods of analysis.

Our system consists of a CRS plus lightweight robot and the peripheral work station. The peripheral has the capability to: add reagent and buffer; stir a solid/liquid reaction mixture; aspirate the liquid phases; filter; and finally concentrate filtrate to residue. All processes are controlled by the robotic arm and computer.

The system was tested for the pentafluorobenzylation of pentachlorophenol with XAD-2 supported reaction as the model. Replicates of 6 analyses were carried out with a relative standard deviation of 15%. Similar derivatizations performed manually had relative standard deviations of less than 10%.

SESSION E

ENVIRONMENTAL ECONOMICS

Oral Presentations

SOCIO-ECONOMIC RESEARCH

André Castel
Corporate Resources Division
Environment Ontario

At the outset of the environmental movement in North America in the late 1960's, environmental protection was felt by many to transcend economic constraints and considerations. Indeed, economic considerations were perceived by environmental advocates to be impediments to the achievement of environmental goals. Because environmental resources and human health threatened by pollutants were considered to be priceless by many people, none of the statutes that were enacted at that time made any mention of economic implications or justification. However, it was soon discovered that resources to implement environmental protection programs were limited and trade-offs had to be made among programs, timing and achievements. Economic principles provide framework and criteria for making these trade-offs.

By the early 1980's, the role of economics in the Ministry was well established. However, nearly every issue that was investigated raised new questions and identified important information gaps. It was then that a Socio-economic component was added to the Research Advisory Committee (RAC) program. Since the inception of this component, the RAC has supported projects on the economics of hazardous waste transport, biotechnology policy, methods to value non-market goods and services, determinants of participation in solid waste source separation and the costs of advanced wastewater treatment methods for metal finishing and plating processes.

Topics for research on economic environmental linkages are listed under six primary issues or subject areas:

- quantification and valuation of pollution damages, risks and disruptions;
- determination of the costs of pollution abatement and environmental protection and their implications;
- development of evaluation tools and their application to proposed policies or programs;
- assessments of industries and businesses which develop and manufacture environmental protection technologies, equipment, products and services;
- social implications of environmental contaminants and their control.
- development and testing of forecasting, simulation and optimization models.

There is a particular need for application of risk assessment methodologies, valuation risk reductions and methods to develop reliable inventories of resources at risk. The key factors which motivate private sector decisions regarding technology choice and environmental program implementation are also of interest. Information is needed about technologies for groundwater protection and cleanup and their costs.

Insights about the factors that could allay citizens' fears and anxieties regarding the location of solid waste incinerator, processing and disposal sites are needed as well as research that will help implement composting, source separation and other waste reduction practices in a big way.

Finally, empirical studies which show how measurable pollution discharges or environmental quality conditions actually affect human uses, activities, expenditures and perceptions are especially needed for use in regulation development and evaluation activities.

It is clear that there are socio-economic aspects concerning virtually every environmental problem or issue. It is also clear that, in the context of the Ministry's RAC program, the socio-economic component provides the opportunity to integrate widely disparate bio-physical, social and economic data into policy relevant frameworks.

E1

UNDERSTANDING ENVIRONMENTAL-ECONOMIC INTEGRATION;
P.A. Victor, VHB Research Ltd., Toronto, Ontario.

SEE ENVIRONMENTAL ECONOMICS RESEARCH SESSION E PROCEEDINGS BOOK FOR THE EXTENDED ABSTRACT.

E2

ECONOMIC VALUATION DISPARITIES AND ENVIRONMENTAL POLICIES. Jack L. Knetsch, Economics Department, Simon Fraser University, Burnaby, British Columbia V5A 1S6.

Consistent findings of compensation demanded measures of environmental losses being from 3 to over 10 times larger than the commonly used willingness to pay estimates have been reported in the professional literature, but they have had no discernible impact on environmental analyses or policies. The cumulative evidence suggests that use of the payment rather than the more appropriate compensation measure is very likely leading to inadequate environmental standards, failure to pursue economically justifiable actions and projects, and to further misallocation of resources. More recent research studies, with early results reported in this paper, are designed to further investigate the implications of valuation differences for a range of environmental issues and policies. While the disparities are due to an endowment effect or loss aversion, of people valuing losses far more than objectively commensurate gains, little direct evidence of this asymmetry has been presented. A more direct simple test and demonstration of this effect has now been developed, and empirical results are reported. Given frequent calls for transferable pollution permits and other forms of economic exchanges to deal with various environmental problems, a real market exchange exercise was conducted to test for the impacts of loss aversion when potential buyers were previously endowed with money entitlements. The results suggest that traditional analyses of such institutions may be unduly optimistic and commonly neglect important factors.

E3

THE PSYCHO-SOCIAL IMPACTS OF EXPOSURE TO ENVIRONMENTAL CONTAMINANTS IN ONTARIO: A FEASIBILITY STUDY. S.M. Taylor*, J. Frank, M. Haight, D. Streiner, S. Walter and N. White, McMaster University, Hamilton, Ontario, L8S 4K1.

Public concern over the possible toxic effects of exposure to environmental contaminants is high in the wake of highly publicized situations such as Love Canal and the Upper Ottawa Street Landfill. The public is becoming increasingly aware of the possible health effects of many sources of potential environmental hazards, including waste disposal sites, industrial facilities, agricultural chemical usage, and natural phenomena such as environmental radiation. While attention has primarily focused on the possible physical health effects of exposure, psycho-social impacts of real or perceived exposure are receiving increasing recognition. Environmental and health agencies within the Province now recognize a potentially important role for public information programmes to disseminate information, the goal being to reduce psycho-social effects, especially those which might be linked to lack of knowledge about the magnitude and extent of risks to health. The first objective of our project is to document the current state of knowledge about the psycho-social impacts of exposure. There is a limited and fragmented literature on this subject. Our multi-disciplinary team is developing a research protocol for a major investigation of the psycho-social impacts of exposure to environmental contaminants in Ontario. Specific research objectives include critical appraisal of the existing research literature, assessment of the strength of the evidence for a causal link between exposure and psycho-social impacts and the development of a conceptual model of the process linking exposure to psycho-social impacts. Preliminary results will be presented concerning the critical appraisal phase of this project.

E4

ECONOMIC ASSESSMENTS OF MISA REGULATIONS FOR DIRECT INDUSTRIAL DISCHARGERS IN ONTARIO.

Orna E. Salamon* and Jack A. Donnan, Policy and Planning Branch, Ontario Ministry of the Environment, Toronto.

The Municipal-Industrial Strategy for Abatement (MISA) is a major initiative of the Ontario Ministry of the Environment, and is intended to achieve "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways." Key elements of the program will be comprehensive monitoring and discharge limits regulations that will be applied to all municipal and industrial wastewater dischargers. An economic component of the MISA program is designed to assess the economic implications of the proposed regulations prior to their implementation. Economic profiles have been prepared for each of 9 industrial sectors whose direct discharges into provincial waterways will be regulated under the MISA program. Estimates of the costs of MISA monitoring regulations are being generated for each sector and the efficiency and distributional implications of these costs are being assessed. To the extent possible, cost-effectiveness of the proposed requirements are being examined. Preliminary results indicate that monitoring requirements alone will total approximately $4.0M for Ontario Petroleum refineries and at least $8.0M for 19 organic chemical plants in the province over the 12-month period of the regulations.

E5

THE EXTRA STRENGTH SEWER SURCHARGE TO REGULATE INDUSTRIAL SANITARY WASTE DISCHARGES. M. Fortin*, Ecologistics, Waterloo, Ontario; G. Zukovs, Canaviro; J. Donnan and G. Zegarac, Ministry of the Environment.

The extra-strength sewer surcharge (ESSS) is a charge levied against industrial users of sanitary sewers by municipal sewerage authorities as a result of the excessive strength of their waste-water discharge. This study investigates the ESSS as one of the potential mechanisms that could be promoted to control industrial sanitary discharges under the Ontario Ministry of the Environments' Municipal-Industrial Strategy for abatement initiative.

Twenty-six out of 192 municipalities or regional municipalities responding to the nation survey had implemented ESSS programs. While this number represents only 14% of respondents, municipalities with these programs were relatively large, accounting for 59% of the service population of all respondents. They tended also to have more advanced treatment systems (primarily secondary or tertiary) and greater numbers of industrial accounts.

All ESSS programs have certain basic features in common, including:

- a formula and rates for determining charge levels;
- a means of identifying who is to be charged;
- a method for determining the strength of chargeable waste water.

Most existing programs focus on larger high-strength waste dischargers and are concerned with the discharge of BOD (or COD), solids, grease and oil.

Major advantages of ESSS programs relate to control of the quality of industrial waste discharges, the equitable allocation of treatment costs and revenue generation. Disadvantages are primarily administrative in nature. Conclusions and recommendations address the need for joint municipal/industrial/provincial collaboration in developing an ESSS policy.

E6

A STUDY OF THE ECONOMIC FACTORS RELATING TO THE IMPLEMENTATION OF RESOURCE RECYCLING OR ZERO-DISCHARGE TECHNOLOGIES FOR HEAVY METAL GENERATING INDUSTRIES IN CANADA. B.Fleet*, J.Kassirer*, T.Burrell, T. Sanger, C. Small and B. Cardoza, University of Toronto.

The clear trend towards increasingly strict environmental legislation and rising costs for treating and disposing of metal bearing sludges, is forcing Canadian businesses to reassess their waste management strategies. In particular zero-discharge, resource recovery technologies are becoming increasingly attractive. The economic factors affecting the implementation of these technologies will be discussed, especially with regards to the surface finishing, printed circuit board, and gold milling industries. The discussion will make use of an economic model that has recently been developed by the authors to assist decision makers in assessing future waste management in these industries. Case studies in each of these three industries will also be presented.

E7

DETERMINANTS OF PARTICIPATION IN SOLID WASTE SOURCE-SEPARATION PROGRAMS IN HIGH-RISE APARTMENT BUILDINGS. Virginia W. Maclaren, Department of Geography, University of Toronto, Toronto, Ontario M5S 1A1

Recycling is an important waste management tool which has gained increasing momentum over the past several years in Ontario. To date, however, most residential recycling programs have been designed for low-rise housing only. The focus of this study is recycling in high-rise apartment buildings. The first step in the recovery of recyclables from the waste stream in apartment buildings is source-separation. The term source-separation refers to the separation of certain materials from the regular solid waste stream by householders. In a high-rise building, these materials may be returned to the building's unseparated waste stream or they may be kept separate and recycled. This paper reports on the results of a survey of 328 apartment buildings in Toronto which found that just under half of the buildings have source-separation programs. This is an important finding because it means that, in a large proportion of high-rise apartment buildings, residents and staff are accustomed to separating their waste and, therefore, these buildings already have a basic system in place for future recycling programs. When asked what problems they foresaw in initiating recycling programs in their buildings, superintendents and managers responded that the three most important problems would be tenant apathy, storage space constraints, and extra work for building staff. The report concludes with a discussion of possible solutions to the issues raised by superintendents and managers.

E8

THE ONTARIO ENVIRONMENTAL PROTECTION INDUSTRY AND THE IMPACT OF ENVIRONMENTAL EXPENDITURES ON THE ONTARIO ECONOMY. L.M. Coplan, Policy and Planning Branch, Ministry of the Environment, Toronto, and A.B. Shenfeld, Woods Gordon, Toronto.

An overview of the current economic activity generated in Ontario as a result of environmental regulations is presented along with the prospects for economic growth of this industry and the perceived impact of free trade on those prospects. Responses from surveys of both users and suppliers of environmental protection goods and services are described. Approximately 28,000 Ontarians are employed in the generation of about $2 billion in annual sales of Ontario-produced environmental protection products and services. Growth in this industry has been strong during the past five years, and growth prospects for the next five years seem quite favourable. An environmental protection impact model (EPIM) is employed to project the potential impact on the Ontario economy of potential changes in environmental regulations. Offsetting the economic impact of additional costs imposed by more stringent regulations is the gain of jobs and production of goods and services in the environmental protection industry and among suppliers to this industry.

E9

Critique and Discussion
E. Cowan, Hickling Associates Ltd.

Examples of environmental-economic integration found in the papers which were presented in this session will be highlighted. Some examples will be drawn from the Speaker's own work concerning the economic impacts of environmental regulation. Changing attitudes and concerns on the part of business and industry with respect to environmental regulation will be discussed as well.

SESSION E

ENVIRONMENTAL ECONOMICS

Poster Presentations

EP1

THE NEW ECONOMICS OF SUSTAINABLE DEVELOPMENT. R.Z. Rivers, Water Planning and Management Branch, Inland Waters Directorate, Ontario Region, Environment Canada, Canada Centre for Inland Waters, 867 Lakeshore Road, P.O. Box 5050, Burlington, Ontario L7R 4A6.

Traditional economic evaluation techniques have come under substantial criticism for their inapplicability to environmental applications. These concerns are particularly worrisome as Ontario's society contemplates the era of sustainable development planning - the integration of environmental considerations into economic planning decisions. The World Commission on Environment and Development, headed by Gro Harlem Brundtland, and subsequently the Canadian Council of Resource and Environment MInisters recommended the development of new tools to achieve more efficient and effective environment-economy integration. This paper provides a critique of current methods of economic evaluation for investment decisions, such as benefit cost analysis, and proposes a set of guidelines and criteria for use in the determination of the degree of sustainability of existing and proposed developments. Further, it suggests a generic approach to the initial assessment of development projects and programs, in both the public and private sectors, that would provide some measure of long term economic sustainablity. An examination of a specific application of this approach to an Ontario location is discussed.

EP2

THE ENVIRONMENTAL EFFECTS OF FORESTRY OPERATIONS IN ONTARIO: HOW MUCH DO WE KNOW ?

Julian A. Dunster. Federation of Ontario Naturalists.

In May 1987 the Federation of Ontario Naturalists commenced research to determine how much knowledge is available about the environmental effects of forestry operations, their extent, and effect on specific envioronments. Research focused at a general level on the overall knowledge and understanding of these effects and more specifically, as they apply to Ontario.

The findings suggest that Ontario has not undertaken as much detailed research as some other forested areas such as the United States and Sweden. For example, knowledge of the effects on aquatic ecosystems and non-game animals in Ontario is weak. Ecological classification schemes are being developed in Ontario but they tend to be applicable primarily to relatively undisturbed ecosystems and have less utility as management tools that can help to predict and mitigate the potentially adverse effects of forestry operations. Forest economics in Ontario is poorly developed and has focused on analyses which ignore many important environmental effects.

Overall, it is concluded that the scale of operations and present methods being used will have some detrimental effects on Ontario's environment. While it is acknowledged that we can never know all the answers, the present level of knowledge and understanding is insufficient to support long-term continuation of the status quo. Several recommendations for change are made, including the need for a greater research focus on environmental matters, a five year audit and review, and a greater dissemination of research results to the front line foresters who are actually making routine decisions that have immediate effects on the environment.